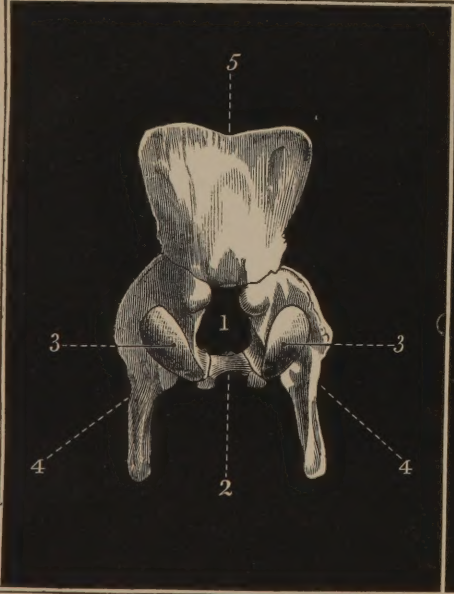
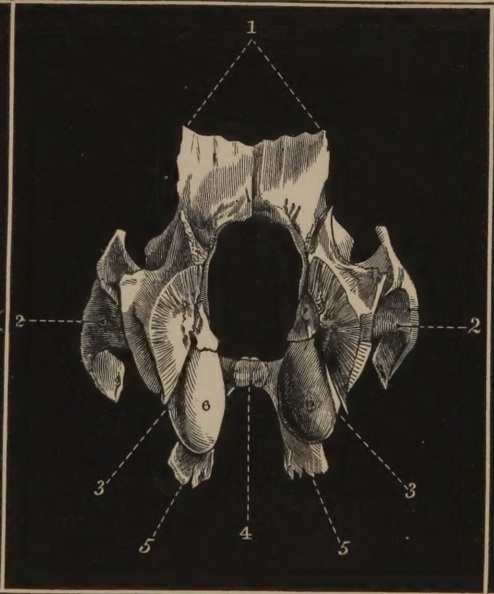
ILLUSTRATION OF CRANIAL VERTEBRÆ . SUS SCROFA.*

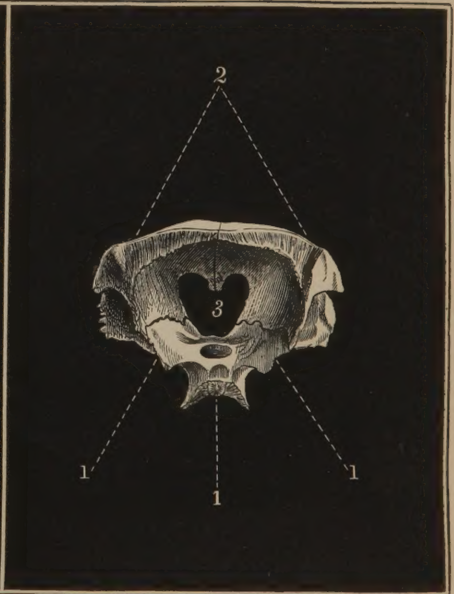
A



B



C



See p. 156, *Vol. I.*

FIG. A. Occipital Bone or First Cranial Vertebra of a Pig.—1. Foramen magnum. 2. Cuneiform process. 3, 3. Condyle. 4, 4. Jugular eminence or transverse process. 5. Part corresponding with vertebral arch and spinous process.

FIG. B. Second Cranial Vertebra.—1. Parietal bones. 2, 2. Squamous portion of temporal. 3, 3. Great wing of sphenoid bone. 4. Posterior part of body of sphenoid. 5, 5. Pterygoid process of sphenoid. 6, 6. Tympanic bone.

FIG. C. Third Cranial Vertebra.—1, 1, 1. Fore part of sphenoid bone including lesser wings. 2. Frontal bone. 3. Opening for the reception of the ethmoidal.

* Each fig. seen from behind.

SPECIAL ANATOMY

AND

HISTOLOGY.

BY

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Multum adhuc restat operis, multumque restabit, nec ulli nato, post mille sæcula præcluditur occasio aliquid adjiciendi. SENECA, EPIST.

EIGHTH EDITION.

ILLUSTRATED WITH ANATOMICAL FIGURES.

IN TWO VOLUMES.

VOL. I.

PROSUNT QUÆ OMNIBUS.

PHILADELPHIA:
BLANCHARD AND LEA.
1851.

PHILADELPHIA:
T. K. AND P. G. COLLINS, PRINTERS.

DEDICATION OF THE SIXTH EDITION.

TO

NATHANIEL CHAPMAN, M.D.,

PROFESSOR OF THE PRACTICE OF MEDICINE IN THE UNIVERSITY OF PENNSYLVANIA.

My Dear Sir:

From the new aspect which it has assumed, I take the liberty of dedicating to you the following Treatise on Anatomy, heretofore without the patronage of an illustrious name. That this is done in the spirit of disinterested friendship and esteem, is manifested by the different paths of professional occupation that we have followed. I have felt the act as an imperative duty from the efficient encouragement in my early years so copiously lavished by yourself; and without which my course of life would, in all probability, have been very different, and much less satisfactory to myself. That a life rendered valuable by talents of no common order; by the kindest and most generous of feelings; and so usefully employed as yours in mitigating the ills of human existence, may be long preserved in its present undiminished vigor of mind and body is the sincere prayer of,

Your obedient servant and friend,

W. E. HORNER.

Philadelphia, *Sept.* 1*st*, 1843.

PREFACE TO THE SEVENTH EDITION.

In presenting to the profession a seventh Edition of his work on Special Anatomy and Histology, the Author remarks, that it is not a mere reprint of the last edition, published three years ago, which itself contained copious additions over its predecessors; but that it has undergone several modifications, and many extensions, derived from the progressive state of the science of anatomy. Where everything else declares such energy in the cultivation of medicine, it was not to be expected that a branch so distinguished in modern times by the indefatigable zeal of its votaries, should remain stationary; anatomy accordingly, though the most settled of all the branches, has not been idle during the interval alluded to, but has been enriched by absolutely new and by more perfect observations.

A comparison of the present edition with its antecedents will, therefore, the Author hopes, show to the student an improved state, in many respects, in regard both to Descriptive Anatomy and to Histology: much of the latter, especially, having been remodelled and written anew since the last edition.

The present edition has also the advantage of additional illustrations from the best authorities, through numerous figures inserted upon its pages: and it is placed in a more immediate relation with the volume of Plates, by Dr. H. H. Smith, called Anatomical Atlas; they having been selected expressly as an elucidation of its text. This connection has been done by specific references at the foot of the page to the Plates in question.

That all has been said which belongs to the science of Anatomy, no one fully acquainted with the subject will admit: but the Author trusts that no well-established fact of leading importance has been omitted; and that a sufficient expansion has been given to the subject to realize the principal object, that of furnishing an elementary Text Book for the use of students of Medicine.

Within the reminiscences of the Author some decided epochs have occurred in the cultivation of Anatomy. At the first appearance of

this work, which was in 1826, Descriptive Anatomy made up almost the whole science, as taught in the schools. General Anatomy was known but little more than by name in this country; and in our parent country had not advanced equally far, in scientific notice. It was strange almost everywhere to British ears, notwithstanding the sagacity and quickness to improvement of that eminent nation; and by some of its distinguished teachers was professedly derided. Its familiarity, at present, with both sides of the Atlantic, marks the solidity of the basis upon which it is founded, and the immense acquisition it has been to pathology and to physiology; its actual state has fully justified the prominent position in which it was placed in my first edition. The same deference then felt for this rich and inviting branch of Anatomy has been retained by me to the present day; and the subject is again presented vastly improved in accuracy and augmented in observations, by perfections in the construction and application of the microscope. Among other novelties of decided improvement in connection with it may be considered the Synonym of Histology, or the doctrine of Texture; which seems to mark its boundaries and intentions with a definitiveness, palliating largely, if not justifying, its substitution for the original phrase itself of General Anatomy; though now sanctioned by half a century nearly of use, and, almost consecrated by the choice of Bichat himself.

If the Anatomy of the period alluded to had a decided impulse beyond that of the preceding century, so the Anatomy of the present period may justly claim a well-marked and triumphant advance beyond that of 1826: organs before unknown, now discovered—arrangements of parts formerly in obscurity, now detected—textures not long ago of an uncertain and disputable character, now elucidated and settled. The anatomy of the most important membranes, as the Mucous, formerly passed over as if there were scarcely any descriptive features whatever in them, now furnished with a detail—extension—and minuteness of observation, leaving the impression, nearly, that there is nothing more to be learned about them. Those untractable and mineral-like bodies, the teeth, exciting once almost the doubt of intrinsic organization, now penetrated by the microscope in a wonderful manner, and exhibiting the most surprising organization: an organization so characteristic and permanent that it has become one of the most efficient means of discriminating, in fragments of animals, the kind to which they belonged, whether of the present or of a former order of the world. Each of the component parts of the teeth, the cement, enamel, and ivory, being found to exhibit a specific organization; its fibrils or its tubules; whose arrangement, in being specific, gives decided character to the specimen in question.

Bichat labored but little with the microscope, too imperfect an instrument at the period of his life, and too discrepant in its indications; his slender use of it may be considered as marking a profound distrust in it; otherwise, with his talents and energy, much more of the ground of modern anatomy would have been covered by him. He depended principally upon maceration, chemical appliances, and pathological changes. But it is now a new instrument, in virtue of its freedom from the imperfections of a former period, and we may here with propriety occupy some space in an exposition of its merits. Invented first by the Dutch or Italians, its improvements have been slow, both in the mechanical and in the optical part. The latter has of course been forced to await the precession of new discoveries in the laws of Light, and as they have been ascertained and developed, the results have been applied to the construction of the Microscope. This instrument was not, however, destitute of interest as far back as nearly two centuries ago; for it was in 1674 that by it Hartsoeker discovered the existence of animalcules in the spermatic liquor of male animals.

The earlier observers generally used single glasses of a lenticular shape; but in a short time followed the invention of the compound microscope, where the image formed by the glass nearest the object became itself the subject of a farther magnifying power. For a long period, however, the imperfections of both kinds of instruments were such as to present the most serious obstacles to correct observations, so that every new eye seemed to give a new cast to microscopical conclusions. One imperfection came from the pencils of light, passing confusedly through a curved surface of glass, and constituted spherical aberration: another imperfection arose from the different coloured rays of light being transmitted through different angles of refrangibility, and constituted chromatic aberration. These difficulties were to a large degree at length surmounted in 1829, by the invention of Wollaston's doublet; since which, improvements have been incessantly occurring both in the optical and mechanical parts of the microscope, in regard to accuracy, power, and applicability.

To appreciate the power of the compound microscope of the present period, we are to remember that the human eye in good order, but unassisted, sees with difficulty an object whose diameter is the hundredth part of a line, say the twelve-hundredth part of an inch; but the powers of the microscope are now so adjusted that the diameter of such an object may be multiplied or amplified one, two, or more thousands of times; thus making what was previously imperceptible, a broad, well-lighted, and well-defined disk or plane. The consequence of this successful construction is that a surface not more than a millionth of an inch across may be satisfactorily examined. We may hence infer the

applicability of the compound microscope in ascertaining the healthy and the diseased condition of the filaments and molecules of the human body; the state of its excretions and secretions; the condition of its fluids; and the manner of germinal evolution.

Of all the fluids of the body, the blood is admitted to be the most interesting from its quantity, and from its relation to all the great functions of life. Containing, as it does, the source as well as the issues of life, every one regards it as no common fluid. At an early period, therefore, the microscope was applied to it, and detected, by the eyes of Malpighi, numerous rounded granules called blood-corpuscles. It was for one hundred and sixty years debated whether these corpuscles were spherical or flat, and for a long time, whether they were solid or perforated: also, their exact size, and the relation of the coloring matter to them. In place of all this uncertainty the facts now admitted are, that they are minute, disk-like cells, containing round or oval nuclei, and having incorporated with them the material which gives redness to the blood of many animals, though this color does not exist in all. Their nucleated state is not so uniform in man as in some other animals, and is supposed to be limited to certain stages of their development when it subsequently disappears. These blood-corpuscles are circular in man, and in all the mammalia, except the camel tribe, in which they are elliptical; all other vertebrated animals, including reptiles, birds, and fishes, have them elliptical. In man the diameter of these globules averages about the $\frac{1}{4000}$th part of an inch, or $\frac{1}{333}$d of a line, some being $\frac{1}{5000}$th and others $\frac{1}{3000}$th of an inch; but in the proteus, where they are elliptical, their length is as much as $\frac{1}{30}$th of a line, or the $\frac{1}{360}$th of an inch. In the Napu musk deer their diameter descends to the $\frac{1}{12,000}$th part of an inch. Omnivorous animals have them larger than carnivorous, and these again larger than herbivorous. There is no absolute proportion between their size and that of the animal to which they belong. Thus, in the elephant their diameter is only twice that of man.

The microscope has also distinguished in the chyle or elaborated part of our food, numerous appropriate globules of variable size, larger or smaller than these of the blood. These corpuscles, when perfect, consist of granules assembled around a central one. Bodies of this kind are found in the lacteals of the mesentery; and bodies nearly analogous, called lymph-globules, are found in the lymphatic vessels, in different parts of the system.

It is well known that human fat is in large part fluid, and such being the case, the inquiry very naturally arose why does not this fluid then gravitate to the legs and feet, like water in dropsy? A reply of problematical truth was given, that this oil was contained in oil or fat cells

like those of the juice of an orange; but the parts were too fine for positive proof. The latter we have now got indisputably from the microscope; the answer first came from Malpighi, but it required near two centuries of observations to verify it.

The cuticle, that important covering of the body, without which the finest satin would feel harsh and excite pain; and also without which no internal supply of fluids could make up the rapid loss from the surface by evaporation—the cuticle, I say, has its structure presented to us in a most interesting light under the new powers of the compound microscope. It is first of all a remarkable point in minute anatomy that, wherever there is a free surface, almost without exception the surface in question is provided with a cuticle, or an analogous structure, as the epithelium, and which consists of one or more layers of primary cells. We hence detect this covering on the entire surface of the skin; of the alimentary canal; of the genito-urinary cavities; upon the secretory ducts; upon the free surface of the peritoneum, pleura, pericardium, arthrodial membranes, synovial sacs, in the cavities of the blood-vessels, &c. &c.

These cuticles or epithelia are all formed of scales, which are found to be cells in a state of compression, and having a nucleus. A pressed lime or lemon will give some idea of the mere mechanism alluded to. The minuteness of microscopical observation may be understood when it is stated that the nuclei of such cells have been ascertained to measure about the $\frac{1}{6,000}$th of an inch, and that within them there are nucleoli estimated at the diameter of the $\frac{1}{60,000}$th of an inch.

Some of the scales or cells are rounded or polygonal, others are cylindrical or conoidal, and others again are terminated at their free extremities, by a very fine down or line of fringe called cilia, whose length is from $\frac{1}{1,000}$th to $\frac{1}{12,300}$th of an inch: some observers claim to have seen them as short as about the $\frac{1}{50,000}$th of an inch. These cilia have during life, and even for some time after death, an incessant motion, sweeping backwards and forwards, and whirling around at their free extremities so as to describe the figure of a cone.

The *Cellular form* is the universal primary condition of all vegetable and animal matter. It lays the foundation of everything, and its traces and modifications may be found in every tissue, at every stage of life, from the earliest rudimentary to the most perfect condition. To Schwann we owe this idea, more prolific in consequences and in philosophical inductions than any other in the category of physiology. It has been applied by Dr. Barry to the tracing of the Embryo from the Germinal vesicle of Purkinjé, to the evolution of all the organs of the body. In every instance it would seem, from the researches of Schwann, Valentin, and others, that organism is first seen as a single

cell; this cell within its enclosure gives birth to others; and from them, in their turn, germinate others; and so the process goes on in an endless succession till life terminates.

Nutrition itself appears to consist in an evolution of new cells from pre-existing old ones, which, becoming effete, are broken down and carried off. While the cells are in a state of active vitality, each set derives from the blood the organic compounds most suitable to their nature; as the structure of every separate portion of the body has a special affinity for some of the particular constituents of the blood, and not for others. The appropriation of these constituents constitutes assimilation, but the regulating power which directs this appropriation is one of the secrets of vitality, the nature of which we are as little likely to know as that of gravitation or cohesion in the phenomena of physics.

It is a remarkable trait in animal organism that a form of growth unknown to it in the healthy state, in fact parasitic, takes possession of certain parts, and, by its evolutions, destroys the matrix upon which it feeds. Thus, in the terrifying and fatal form of disease called Cancer, which is so apt to assail the glandular textures of the human body, it has been shown by Müller and others, that it consists in the growth of a mass of cells, which develop themselves in their successive generations with extreme rapidity; and destroy the surrounding tissues both by pressure and by abstracting the blood essential to their nutrition. These parasitic agglomerations have an independent power of growth and of reproduction, and can be propagated into healthy animals by inoculation. It is even said that vegetable organisms have been latterly traced in the parasitic state upon the body of animals; so that a true plant has been found having a regular apparatus of nutrition and of reproduction.[1] We have it announced too by MM. Andral and Gavarret, that in all albuminous fluids, a trivial chemical appliance of a certain kind will develop an infusory vegetable, to be found with the aid of the microscope.[2]

Color, it is now ascertained, depends upon the existence of a particular class of vesicles, called Pigment Cells. From them are derived the black pigment of the eye, and that which marks the distinction of races in the human family. In these, as in other instances, the pigment is composed of minute dark granules deposited in primary cells. These granules are among the most minute formations of the body, and in their longest diameter measure only $\frac{1}{20,000}$th of an inch.

[1] Carpenter, Human Physiology, first Am. ed., p. 404. Numerous observations on the parasitic plants of animals, and especially of insects, have been made within the last two years by Dr. Leidy. See Proceedings of the Acad. Nat. Sciences, Phila., 1850 and 1851.

[2] Bulletin of Med. Science, by J. Bell, M. D. Sept. 1843, from Gazette Médicale.

The nails of the fingers and toes, simple and inorganized as they seem to be, are yet found by the same searching process to be formed from an aggregation and successive growth of cells.

Muscular tissue has also received a copious elucidation from this source of observation. A point is now definitively settled, that the muscular fibres of the stomach, bowels, and other interior organs are very different in their anatomy from the muscular fibres of the limbs, and such generally as are engaged in the larger motions of the body. The nerves, formerly considered as mere strings, are now ascertained to be tubes. These tubes are collected into fasciculi making a chord of some magnitude. To superficial observation, these tubes or ultimate fibres seem to coalesce by reciprocal anastomosis; but it is now settled by the microscope, that from the brain and spinal marrow to the peripheral or outer termination of these tubes, they keep perfectly and exactly distinct from each other. But as each nervous fibril has its distinct origin at one point of the brain, and its distinct termination at the other end upon a muscle or a sentient surface, the action of the muscles and the perceptions are better regulated and more precise than they would be under a different arrangement.

With such augmented means of anatomical research, the progress of the science has been immense. Contributions of the most valuable kind have been made in the British dominions, in Germany, France, Switzerland, and elsewhere. Modes of elucidation by plates, drawings, models, and injections have been improved. Cabinets of great value have been collected and arranged, in every direction. Our own country has felt this salutary impulse, by advancing in its scientific labors and books, increasing its medical schools, multiplying highly instructed teachers of anatomy, and imparting a more finished degree of accomplishment to its medical graduates.

Under the circumstances actually existing, therefore, in the civilized world, there has never been a period more propitious to the cultivation of Anatomy; and to the acquiring of points of knowledge indispensable to the scientific and successful treatment of disease. And it is in this view of being useful, that the Author once more submits his labors to the profession.

PHILADELPHIA, *October* 1846.

PREFACE TO THE EIGHTH EDITION.

A CONTINUOUS demand for the Treatise on Special Anatomy and Histology having made the present edition expedient, the author has endeavored to introduce such improvements into it as the advancing condition of anatomy seemed to require. This edition is distinguished from the preceding ones by very copious illustrations, amounting in all to more than three hundred. Many of these illustrations are taken directly from nature, they being intended to explain the author's peculiar views on points of anatomical structure, which his own personal experience led him to infer was correct. Others are from the Anatomical Atlas of Dr. H. H. Smith, which was used as a special reference in the seventh edition of this work. While the remainder are from various sources, embraced in the large collection of Anatomical Engravings in the hands of the publishers.

An index to the figures will be found at the beginning of the work; and though, from accidental causes, the original source of them cannot be traced in every instance, yet the author has endeavored to steer clear of any presumptive claim to such, by stating specially such as have emanated from his own dissections and observations.

As the composition of this work has been in strict reference to the course of study pursued in the University of Pennsylvania, it has been kept in as compendious a state as possible, so that there should be no unnecessary loss of time in perusing it. That it will meet all the requisitions of an enlightened and well-exercised judgment in others is what the author can scarcely expect; he has, however, spared no pains to make it as useful as the circumstances admit, and with that view introduces it to the public attention in its new form.

PHILADELPHIA, *July*, 1851.

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When the Wistar Museum is referred to in connection with any of the foregoing illustrations, it means, almost without exception, that the preparation was executed by Dr. Horner, though the figure may have been originally presented in the Anatomical Atlas, or elsewhere.

The writer, in endeavoring to credit each author for his figures, laments his inability to do justice in every case, owing to the intermixture which has occurred in the progress of time. It would benefit much the cause of science, if every writer had been careful to assign correctly the origin of his figures, specially in each instance; and particularly whether they were from nature; or mere modifications of

figures already published, a practice, unhappily, too much followed. From such omissions, it is extremely difficult to know, in some instances, to whom the first credit is due, and errors, therefore, among us are almost unavoidable, from the want of a good sequence of authority from the original. I have endeavored to make proper references of authority, even when there was neither elevated merit nor originality in the figure; but should any material omission have occurred, shall regret it much, with the desire to amend it on a future occasion. The celebrated work of Caldani, containing the reproduction of the best anatomical figures up to his day, but by him properly accredited to their authors, has been a very prolific mine for such as like to do but little in the way of practical anatomy for themselves; and the vestiges of it are seen in every direction in figures of reduced size and so on, without due acknowledgment to him or to the authority which he has himself very honestly quoted. An examination of its pages will show that it has been in fact the most fertile supply for transpositions and for reductions in size to be found in the profession; and though this originating source is very evident in a great number of figures accredited to others in these references, I have thought it, perhaps, better not to disturb the account, at least for the present.

INTRODUCTION.

CHAPTER I.

HISTOLOGY, OR GENERAL ORGANIZATION OF THE HUMAN BODY.

In passing the eye over the structure of the human body, it is evident that the latter is formed by an aggregation of organs and of textures; each adapted to some particular function of a vital or of a mechanical kind; the apparatus of the two functions, vital and mechanical, being in many instances blended. Some of the organs are of a character so peculiar that their texture is repeated nowhere else; other organs have their texture exactly renewed in numerous places; a good example of which is seen in the muscles, where, from the necessity of motion, muscular structure exists at many points, both for locomotion and for the internal operations of the body. Anatomy as a science has for its object to portray all these component parts, both solid and fluid, under whatever circumstances they may be presented.

The application of the science to the search of the same texture in different organs, and wherever it may indeed be found; the tracing of its degree of extension and its modifications under all circumstances; in fine, a general comparison of it, one parcel with another, constitutes what is called General Anatomy, or Histology.[1] Each individual texture is in technical language a tissue.

Special or Descriptive Anatomy, in distinction from Histology, teaches the exterior form of organs, their magnitude, their position, their connections with adjacent parts; and their intimate texture or organization. As in this way every individual part is brought under a strict review, it is the knowledge of this portion of the science which gives skill to the surgeon.

General Anatomy may be explained, as its great founder, Bichat, himself has done it, by the following comparison. Chemistry has its

[1] From ιστος texture, and λογος word, *doctrine of texture.*

simple bodies, as heat, light, hydrogen, oxygen, nitrogen, carbon, and so on, whose several combinations form all the composite bodies on the face of the globe. In the same way anatomy has its simple tissues, whose varied combinations form all the organs of the human body and of animals.

Bichat admits twenty-one elementary tissues, but several of them are but modifications of one and the same.

Many other modes of classification have been proposed since Bichat's; they have for the most part been received by the profession with indifference, as not furnishing sufficient inducements for a change. That of Bichat originating with himself has become so completely identified with the ordinary language of anatomy and pathology, that it is by no means probable that it can be supplanted by any other. Among the most modern of the suggestions of change are those of Schwann, who proposes a classification of tissues upon the basis of their cellular histogeny. Valentin and Gerber have also made efforts at a new system, and have had no better success than their predecessors.[1] Some subdivisions and additions have been made with advantage under the improved application of the microscope, but no general renewal can take place at present upon existing grounds of information.

The following distribution will include the ideas of Bichat as qualified by the actual state of microscopic anatomy. The primary tissues having characters absolutely distinct from all others, and the secondary being merely modified forms of the primary.

PRIMARY TISSUES.	SECONDARY TISSUES.
I.—The Cellular or Areolar.	*a.* Serous membrane, as pleura. *b.* Synovial membrane, as in joints. *c.* Inelastic fibrous tissue, as in tendons. *d.* Elastic fibrous tissue, as in yellow ligament. *e.* Vascular tissue, as in blood-vessels and absorbents. *f.* Cutaneous or dermic. *g.* Erectile or spongy.
II.—Simple Membranous.	*a.* Basement membrane. *b.* Posterior layer of cornea, capsule of crystalline.
III.—Adipose tissue.	*a.* Elain. *b.* Stearin. *c.* Margarin.
IV.—Epidermic.	*a.* Cuticle. *b.* Hair. *c.* Nails.
V.—Pigmentary.	*a.* Rete mucosum of skin. *b.* Pigmentum nigrum of eye.

[1] See Encyclop. Anat. vol. vi. p. 131, Paris, 1843.

VI.—Mucous.	*a.* Alimentary canal, &c. *b.* Nasal sinuses.
VII.—Muscular.	*a.* Animal life or striated. *b.* Organic life or non-striated.
VIII.—Nervous.	*a.* Cerebro-spinal axis. *b.* Nerves, animal and organic.
IX.—Cartilaginous.	*a.* Pure cartilage. *b.* Fibro-cartilage.
X.—Osseous.	*a.* Skeleton. *b.* Dentine and enamel of teeth. *c.* Crusta petrosa of teeth.
XI.—Glandular.	*a.* Follicles. *b.* Tubes of marked length. *c.* Racemose or branched tubes.
XII.—Corpuscular.	*a.* Blood. *b.* Lymph. *c.* Chyle.

The distinctions of tissue do not rest upon an imaginary basis, but have nature for their foundation. The organization of each has well-marked and characteristic peculiarities, which may be ascertained by their diseases, and by the influence of different agents, as heat, air, water, acids, alkalies, neutral salts, and putrefaction. Each tissue has its particular strength, and its particular mode of sensibility, upon which repose all its vital phenomena, and the blood is but a common reservoir, where each chooses what is in relation to itself. An example, however, will serve better for illustrating these several points. The stomach is composed of four laminæ; one is serous, another muscular, a third cellular, and a fourth mucous. Each of these laminæ has its appropriate sensibilities and mode of life, which may cause it to be diseased, while all the others are healthy. Peritoneal inflammation may invade the first, the cramps of colic the second or muscular, the infiltration of dropsy the third or cellular, and dyspepsia the fourth or mucous.

The several tissues may, therefore, be considered as animal matters, endowed each with its own especial vital force and physical properties, from the union of which results the especial physiological action of the part under consideration.

It thus happens, that the diversity of the tissue of an affected organ modifies the symptoms of its diseases, and particularly their duration. Hence, nothing is more vague in medicine, in regard to duration, than the terms chronic and acute. An inflammation in one tissue will go naturally through its stages in a few days, as, for example, in the skin, cellular substance, mucous membranes; while in the bones and ligaments, on a natural progress being also observed, weeks and months

are required for its accomplishment. It is evident, therefore, that a time which is chronic in the first three tissues is acute in the last two.

A chemical analysis of the body demonstrates only a few elementary principles; and they are varied in their combinations by a greater or less proportion of one or the other. Calcareous matter, the neutral salts, carbon, hydrogen, oxygen, nitrogen, sulphur, iron, wrought up by the powers of animalization into gelatin, albumen, and fibrin, which again are elaborated into the filamentous and laminated tissue, constitute nearly the sum total of the results of the experiments of animal chemistry. It has yet to find out the laws which give to these elementary atoms the condition of blood, and afterwards change this blood into muscles, nerves, and other tissues.

The whole body is formed of solids and of fluids. The former, when unraveled, consist of filaments, of laminæ, and of molecules; their mechanical division does not admit of any greater separation. Many of the laminæ are arranged into membranes, thus forming hollow viscera, for containing either articles of food or the excretions; others surround the different solid viscera and separate them from the contiguous parts. Other laminæ penetrate through the most compact structure, and indeed form the nidus in which its atoms or particles are deposited. Many of these laminæ consist of several thinner laminæ, placed together and united by filaments arranged into cells, which cells receive the ultimate particles of the whole fabric, and constitute its base. The laminæ also, by being wrought into cylinders, constitute vessels of different kinds, which are distributed in such number through the body that by far the greater part of its structure seems to be formed of them. In regard to the fluids, they are extremely abundant in number and in quantity, and are found in the cells of the laminated tissue, and in the several vessels. One not accustomed to the process would be astonished to see, when these fluids evaporate by exposure to the air, that nearly all parts of the body, except the skeleton, lose from one-half to two-thirds of their original bulk, and some parts even more. The several solid parts of the body are then literally kept soaked during life in the fluids; which have for a principal constituent simply water.

There are some animals whose organization is so simple, that they possess only the power of sensation, and of motion in one part upon another. This is perhaps the lowest degree in which animal life does exist, or possibly can exist without a new order of things. These qualities, sensation and motion, are of necessity combined always; they constitute the first ingredients in the composition of life, both in vegetables and animals, and by being modified in various ways by their application to different organs, may be traced up to the perfect animal, man.

Nutrition is the first want of every being, and is one of the modes of sensation; therefore, before any other apparatus is provided for animal life, means are resorted to to carry it on. Vegetables are fixed to the soil, and are furnished with great numbers of porous roots, which, by spreading in different directions, come in contact with the moisture of the ground and by simple absorption conduct it as the aliment of the plant. There are many animals which have a vegetative life almost as simple as this, and are fixed permanently to the spot where they came into existence; others are permitted to change their places of abode, and a provision for nourishment by roots would not answer; hence comes the necessity of a stomach, or reservoir in the interior of the body, into which aliment may be introduced and transported along with the animal. In many instances this stomach seems to constitute the whole animal, as in a hydatid: it receives such simple fluids as compose the medium in which it resides, and carries on its digestion, with so little change of the alimentary matter, that there seems to be nothing of an excrementitious kind, as commonly understood, thrown off. These animals are found abundantly in the waters of tropical regions, exist sometimes in the brain of man, and of sheep; in the uterus, and in almost every part of the body. But, again, there are stomachs of a more complex kind, which have opening into them a great number of absorbing orifices, called, in the striking language of Boerhaave, "genuine internal roots." These stomachs may admit fluids only, or they may be large enough to receive considerable masses of solid aliment. In the latter case exists the necessity of teeth, or some mechanical means of triturating the solid food into such fine pieces as will admit of its being exposed by an extensive surface to the action of the stomach. But as much of the matter thus carried in is unfit for assimilation, and there may be even more of it than is required, an intestinal canal is provided, by which it is carried out again. Here then commence the phenomena of a true digestion, with all its modifications and stages.

The very simple structure of a plant and its permanent locality are attended with a circulation of its juices equally simple; which is performed and maintained by the capillary attraction of its pores, and by evaporation from its higher and more exposed parts. This circulation is the more rapid as the evaporation becomes greater; but the latter may become changed into absorption by the humidity of the atmosphere; and the circulation be as a consequence reversed from the branches to the roots. But it is evident that such animals as possess extensively the powers of locomotion, besides having organs more numerous and more complex than the parallel fibrillæ of vegetables,

will frequently find themselves in such conditions of temperature and locality, that a similar circulation of the nutritious fluid in them could not be maintained. Hence it is necessary to have more powerful and regular agents for carrying on the circulation. They, therefore, are furnished with innumerable blood-vessels, called arteries and veins; which have a common centre, the heart, for propelling through them the blood, or nutritive fluid, to all parts of the system. From the heart being furnished with valves, which are all in one direction, the blood can flow only in a corresponding course; thus it is forced by the heart into the arteries, and after moistening the most minute fibres it is received into the capillary extremities of the veins and brought back to the heart, where it receives another impulse, and performs again the round of the body and so on in succession. This phenomenon is called the Circulation. When it exists in animals, blood is always to be found; for the most part red, but in many species white or transparent. The use of the blood in them is to receive from the alimentary canal, from the skin and lungs, such matter as has been assimilated, and to convey it to every part of the body, for the purpose of repairing its waste, or providing for its growth. It is at the very extremities of the arteries that this deposit occurs, and the blood getting into the veins loses its bright vermilion color, becomes of a modena or dark blue, and is no longer fit for the purposes of life till some of the principles which it has lost by this passage are restored to it. This restoration takes place in the lungs, where a sort of combustion is performed by the absorption of oxygen. This process is called Respiration, and it exists in all things that live, under various modifications of the apparatus performing it. In man it is performed in two cellular air bags, which have a heart independent of the one just mentioned, for propelling the blood through the ramifications of their vessels. In fish there are gills, which have their surfaces exposed to the water, and are aerated by the air contained in the water, and the same heart which supplies the general circulation also fills a large artery that is distributed very minutely through the gills. But in insects, where there are no blood-vessels, and the nutritious fluid is contained in cells, there are, distributed over their bodies, air-tubes, which transmit atmospheric influence.

The blood-vessels, in addition to the function of carrying nutritious matter, perform an essential part of a very different character. All the atoms of which the body is composed, after residing in it for a time, become no longer fit for use; their farther residence is, in fact, injurious, and it is necessary to remove them. A system of vessels is provided for this purpose called the absorbents, which are the scavengers of the body. Taking up, therefore, these effete atoms, they con-

vey them into the blood-vessels, where they are mixed with the common mass of blood. Several organs are provided, as the liver, the kidneys, the surface of the body, and the lungs, through which these effete particles are discharged from the blood in the form of excretions; as the bile, the urine, perspiration, and pulmonary exhalation.

We have now sketched the human machine as far as its internal existence, or self-preservation, is concerned in the functions of digestion, circulation, respiration, and excretion. Let us proceed in the inquiry by a rapid glance at those organs by which it is put into relation with surrounding objects, and on which it depends for the sublime operations of the understanding.

Sensation is derived from the nervous system, composed of the brain, the spinal marrow, and the nerves. The latter may be traced to many parts of the body, and are supposed to be distributed to all. They maintain its different sympathies, keep the several organs in one harmonious course of action, and, in some instances at least, are indispensable to the performance of their functions. In addition to these, many of the nerves have at their extremities organs of a particular construction, each fashioned in the best manner for the execution of its office in making us acquainted with exterior objects. The interior extremities of all these nerves terminate either in the brain or spinal marrow; the external are the points intended by nature to be affected by the objects around us; but it is indispensable to consciousness that their line of communication with the brain be not interrupted. The sense most extended is that of the touch, which is enjoyed by all parts of the surface of the body; the others are thought, by very respectable physiologists, to be only more exalted modifications of it, and are susceptible of more delicate impressions. It is scarcely necessary to mention that the other sensations are executed by the eye, the ear, the tongue, and the nose.

The Sense of Touch is the most important of all, and the least liable to error in its reports. To exercise it, it is necessary for the body under examination to come into contact with ours; hence, its operations are so mechanical that but little is left to the imagination, and they, therefore, serve to verify and to correct the impressions on the other senses, more particularly those on the eye. It is the sense of touch by which we learn accurately the dimensions of bodies, and the figures of such as are hard. The hand, or any other part, by being applied to them in various directions, informs us whether they are flat, round, or angular. A greater or less degree of pressure informs us whether they are soft or hard, and, by rubbing, we ascertain whether they are

rough or polished. The resistance they make to motion teaches us whether they can or cannot be moved, and their being impelled against us shows the momentum with which they act, as well as its direction. Our ideas of heat and of cold are also derived from this source. It is not asserted that all parts of the surface of the body enjoy equally the sense of touch; on the contrary, this sensibility is more or less active according to the organization of the part, and as its nerves are more or less numerous and exposed; hence we find it most exquisite and perfect in the ends of the fingers. This, therefore, being the most important of the senses, the magnitude of its influence on the habits and intelligence of different animals is immense.

Man, from the nudity and the delicacy of the texture of his skin, derives, from this source, a discrimination and refinement, in regard to the nature of bodies, much superior to what many other animals possess.

The Sight enables us to distinguish the color, the quantity, and the directions of the rays of light which proceed from a luminous body; or, in other words, to ascertain its situation, size, and figure. In each, however, of the latter we are exposed to great deception; for the rays of light, by falling on a mirror, or any other plane reflecting surface, before they reach the eye, will induce us to believe the body to be in that direction. Bodies which are near reflect more rays of light than such as are distant: we thus estimate distance by the eye; but it happens continually that some bodies naturally reflect more rays than others, in consequence of which a very luminous body, at a great distance, will frequently be thought to be much nearer to us, than such as are more within our reach. Mistakes of this kind can only be corrected by the sense of touch, and our habitual reference to it, and continued experience, finally enable us to form prompt and just decisions. The eye, however, infinitely exceeds the touch in the rapidity with which it communicates ideas, and also in the extensiveness of its application in a single moment. It is, therefore, an organ of the first utility in making us acquainted with surrounding objects. Man does not possess it to that great perfection that some other animals do; he can neither see so far as the vulture or eagle, nor so minutely as the fly; yet his ingenuity has enabled him to excel both. For, with the telescope, he examines worlds in the immensity of space, which, under common examination, are either invisible or form mere points in the heavens, and with the microscope he sees the texture of the most minute object.

The Ear, along with the powers of articulation, enables the whole human family to make common stock of the knowledge which each individual may possess. As connected with the preservation of the

individual, it is much less important than the eye or the touch; yet, considering it as a means by which we receive knowledge and impart it to others, the aggregate of human intellect depends for its present state and future improvement essentially upon it. In its acuteness, we are much inferior to many other animals; neither have we, by instruments, been able to do much in improving it; yet, by cultivation and by studying its most minute and delicate impressions, an endless source of instruction and amusement has been opened to us in the intonations of language, and in the enrapturing strains of harmony. It eminently qualifies man for the social state, occasionally warns him of danger, and allures him to such things as are useful to his subsistence.

In regard to the Taste and to the Smell, they make us acquainted only with such objects as are necessary to our subsistence. They are enjoyed too imperfectly by man for them to become a fruitful source of his intelligence. As they principally lead us to filling the stomach, and to debasing the intellectual man into the beast, that eats and dies, the wisdom of nature is as fully demonstrated in the imperfection which she has put upon these senses, and in our inability to improve them, as in the exalted and varied degrees to which she has carried the others. The keenness of the scent of the hound, and the discriminating nicety of the bee, in opening sources of enjoyment merely physical, would have degraded, instead of elevating us, by engrossing our time and ingenuity in the development of pleasures incompatible with our constitutions and destinies.

Man being thus organized, it is worthy of inquiry in what his life consists. According to the celebrated Bichat, it is "the aggregate of those functions by which death is resisted. For such, indeed, is the condition on which we live, that every thing surrounding us has a tendency to produce our dissolution, by the affinities existing between their atoms, and the atoms of which a living body is composed. It is plain, therefore, that the principle of life, like all other principles in nature, incomprehensible in itself, must be studied by its phenomena."[1]

There are two remarkable modifications of life; one is common to the vegetable and to the animal, the other is the exclusive attribute of the latter. Under the first modification, are included assimilation and excretion, which, though exercised under apparently different circumstances in animals and in plants, are probably essentially the same in both. This modification is termed by Bichat, Organic Life. By the second modification of life, the animal has a more extended sphere of

[1] Recherches sur la Vie et La Mort.

existence than the vegetable, is put into a certain relation with all the objects that surround him, is made the inhabitant of the whole world, and not, like the vegetable, confined for ever to the place of its birth. By it the animal feels, and is conscious of external objects, reflects upon them, moves voluntarily, and can communicate, by the voice, his wants and apprehensions, his pleasures and his pains. The functions included under the second modification are termed, by Bichat, Animal Life.

Each of these lives has two orders of functions, keeping up its connection with the objects destined for its existence. In animal life, one of these orders may be said to commence at the surface of the body, and to be extended towards the centre, the impression of exterior objects affecting first the senses, then the trunks of nerves, and lastly, the brain. A second movement, constituting the second order of functions, is afterwards made from the centre to the circumference, by which the influence of the brain is exercised on the organs of locomotion and of voice. These two functions, in animal life, are perfectly equivalent in their operations. He who feels the most, will also act the most. Early life is the period of quick and multiplied sensations, so is it the period of quick and multiplied movements. A partial, or a total privation of the sense of sight, causes us to move cautiously and slowly onwards. The suspension of our communication, through sleep, with exterior objects, causes also a suspension of the faculties of locomotion and of voice.

In organic life, the first order of functions assimilates to the animal the substances which must nourish him, and includes digestion, circulation, respiration, and nutrition; under the influence of which four functions, everything must pass before it can be assimilated. But, after a temporary residence, the assimilated particles, becoming effete and noxious, have to be carried away out of the body: by which means the second order of functions in organic life is established, consisting of absorption, circulation, exhalation, and secretion.

The two functions of organic life differ, however, from those of animal life, in not observing, on all occasions, an equivalence of action: the diminution of assimilation does not involve a corresponding diminution in excretion; hence, follow emaciation and marasmus, conditions in which, assimilation ceasing in part, dis-assimilation is exercised to the usual extent, or near it. From this sketch, it is seen that the circulation of the blood is the connecting link of the two orders of functions in organic life, as the brain is the connecting link of the two orders of functions in animal life. The blood is, therefore, in fact, composed of two parts or descriptions of matter: one is recrementitial, derived from the aliment, and subservient to the renovation and growth of parts;

the other is excrementitial, derived from the wrecks of all our organs, and under the necessity of being cast away as useless.

M. Bichat thinks the division of life into Animal and Organic fully warranted by their differing much from each other in the exterior shape of their respective organs, in their mode of action, in the duration of their action, in the effects of custom or habit upon them, in their relation to the moral part of man, and in their vital force.

One of the most prominent differences in the two lives is the symmetry and duplicity of the Organs of Animal Life, and the irregularity in shape of those belonging to Organic Life. The impression of Light is received by two organs exactly alike. Hearing, Smelling, Touching, are likewise performed by organs having their congeners on the opposite sides of the body; and even Tasting, though apparently performed by one organ, has that organ divided into two equal and symmetrical parts, thus making it like the other organs. The whole exterior surface of the body is, indeed, manifestly divided into two equal parts, marked off from each other by the fissure in the nose, the upper lip, the chin, the raphe of the scrotum and perineum, the spinous processes, and the depression in the superior posterior part of the neck. The Brain and Spinal Marrow, as belonging to animal life, consist of two halves, presenting corresponding arrangements in the development of cavities and prominences, and so on, and in sending similar nerves to the organs of locomotion and of voice.

The organs of organic life are marked, on the contrary, by the character of striking dissimilitude in their two halves, as manifested in the liver, the spleen, the stomach, the intestines, the heart, and the great vessels belonging to it. There are, however, some organs of organic life in which the difference is less prominent, as the lungs of the two sides, the pulmonary arteries, the veins, the trachea, the kidneys, the capsulæ renales, and the salivary glands.

From what has been said, we are, perhaps, prepared to admit with M. Bichat that animal life is double; that its phenomena being executed after the same manner on both sides of the body, it is very possible for the actions of one side to be suspended or destroyed while those of the other go on. This, in fact, happens in certain palsies, where the sensibility and motion of one side are so completely suspended that it resembles a vegetable; all relation with exterior objects being cut off, and nothing but the function of nutrition being preserved; whereas the other side retains all its animal properties. For these reasons Bichat has very quaintly observed that we have a right life and a left life. In organic life, on the contrary, the functions of the two halves of any organ are so allied, that the lesion of one affects the

other. The liver, in a disease on one side, has its functions impaired throughout: it is the same with the intestinal canal, and with the heart.

Congenital deformities are said to be more frequent in the organs of organic life than in those of animal life. Several cases have occurred, and Bichat relates one which happened in his own amphitheatre, where there was a general displacement of the digestive, the circulatory, the respiratory, and the secretory viscera. The stomach, the spleen, the sigmoid flexure of the colon, the point of the heart, the aorta, and the lung with two lobes, were all on the right side. But the liver, the cæcum, the base of the heart, the venæ cavæ, the vena azygos, and the lung with three lobes were on the left side. All the organs placed beneath the middle line, as the mediastinum, the mesentery, the duodenum, the pancreas, the division of the trachea, were reversed. I have had occasion to observe, in our own dissecting rooms, two cases of the caput coli removed from the right iliac into the left iliac region; the colon was of the common size and length, and being confined to the left side of the abdomen, formed there a loop, which ascended into the left hypochondriac region, and then descended as usual. In these cases, as there was no transverse mesocolon, the duodenum had all the coats of the other intestines; and was not attached to the front of the right kidney and to the spine. One of these was an adult female subject of considerable corpulency, the other a corpulent male.

Another difference between organic and animal life exists in the mode of action of their respective organs. Each of the organs of animal life being double, our sensations are the more exact, as there exists between the two impressions, from which they result, a more perfect correspondence. We see badly when the images transmitted to the brain are derived through eyes of unequal strength. Without knowing this law as theorists, we instinctively show its influence in shutting one eye while looking through a convex glass; whereby we prevent a confusion of images arising from two impressions of unequal force concerning the same body: when one eye is weaker than the other, we squint involuntarily, and it finally becomes a habit, in order to avoid the confusion of perception from two unequal images on the brain. This accounts for squinting, both in early life, from some congenital cause, and for that squinting which is the result of inflammation, in more advanced life. A little reflection on this head will satisfy us; for, as a single judgment or perception is, for the most part, formed from the two impressions, one on each eye, how is it possible that this judgment can be accurate, when the same body is presented at the same moment with vivid or faint colors, accordingly as it was painted on the strong or the weak eye?

The ear is subjected to the same law as the eye. If, in the two sen-

sations composing the act of hearing, one is received upon an organ better developed than the other, and more discriminating in its functions, it will leave an impression more clear and distinct; but the brain, being affected simultaneously by the unequal impressions, will be the seat of an imperfect conception. This case constitutes a false ear in music, and from the impressions being continually confused, prevents the individuals from judging rightly between harmony and dissonance.

A similar reasoning has been founded by Bichat upon the structure of the Nose, Mouth, and Organs of Touch. He believes also that the brain itself, as the seat of the mind, may become the cause of error in our ideas, when the two halves of it are not perfectly alike; for example, if one of the hemispheres be more strongly organized than the other, better developed everywhere, and more susceptible of a vivid impression. The brain transmits to the soul the impression or impulse derived from the senses, as the latter transmit to the brain their impressions; it is, therefore, to be believed that the soul will perceive confusedly, when the hemispheres, being unequal in force, do not blend into one the double impression upon them. In proof of this, it is common to see mental derangements depending on the compression of a hemisphere by effused blood, by pus, by depressed bone, and by an exostosis from the internal face of the cranium. Even where every sign of compression is removed, the hemisphere occasionally takes a long time to regain its action, so as to recover from the alienation.

This harmony of action exists also in the organs of locomotion, and of voice; and anything which interrupts their symmetry destroys the precision with which their functions are executed.

Opposed to this harmony in the shape and functions of the organs of animal life, the most striking differences may take place between the organs of organic life, without much disturbance in the general result. For example, in disparities of the kidneys, of the lungs, of the salivary glands, &c., their functions are not, by any means, the less perfectly performed. The circulation remains the same in the midst of the frequent varieties of the vascular system on the two sides of the body, whether those varieties exist naturally, or whether they depend upon artificial obliterations of the large vessels, as in aneurism.

Another very striking difference in the two lives may be observed in the duration of their action. All the excretions proceed uninterruptedly, though not uniformly. Exhalation and absorption succeed each other incessantly; assimilation and disassimilation follow the same rule. On the other hand, every organ of animal life, in the exercise of its functions, has alternations of activity and of complete repose. The senses, fatigued by long application, are for the time

disqualified from farther action. The Ear is no longer sensible of sounds: the Eye is closed to light; sapid bodies no longer excite the Tongue; the Nose is insensible to odors; and the Touch becomes obtuse. Fatigued by the continued exercise of perception, of imagination, and of memory, the brain has to recruit its strength, by a state of complete inactivity for some time. The muscles, relaxed by fatigue, are incapable of farther contraction, till they have been permitted to rest; hence the necessary intermission, in every individual, of locomotion and of voice.

This intermission of action is sometimes extended to all the organs of animal life at the same time; on other occasions, only a part of them is affected by it. It is in this way that the brain frequently continues in the active exercise of thought, while the senses, as well as the powers of locomotion and of voice, are suspended.

In addition to the foregoing views, it has also been suggested by Bichat, that another striking difference between organic and animal life is found in the epoch and mode of their origin. Organic life exists from the first moments of conception; but animal life does not commence till after birth, when exterior objects are established in a certain relation with the individual. It is more than probable that the functions of the Eye, the Ear, the Tongue, and the Nose, do not exist in such manner as to communicate their several sensations in the fœtus; and that the enjoyment of a sort of indistinct sense of touch, arising from its striking against the parietes of the womb, is the only circumstance which can give the latter any idea of its existence; it is, however, doubtful whether it has even a consciousness on that point. The organic life, on the contrary, of a fœtus, though not so complicated as afterwards, is still remarkable for the promptitude and vigor of some of its functions, particularly of assimilation; and in a very short time after birth, all the organs which it employs reach their highest degree of perfection, and thus present a very different case from the organs of animal life.

The distinction of the two lives is farther kept up in their manner of ceasing in old age. Natural death, says Bichat, is remarkable in terminating animal life, almost entirely, a long time before it does organic life. The functions of the first cease successively. The Sight becomes dim, confused, and is finally extinguished. The Ear receives the impression of sounds indistinctly, then faintly, and afterwards they are entirely lost upon it. The Skin becomes shrivelled, hardened, loses many of its vessels, by their obliteration; and is only the seat of an obscure and indistinct touch; the hair and beard become white, and fall from it. The Nose loses its sensibility to odors. Of all the

senses, it has been often remarked, that the Taste remains the longest, and exhibits the last efforts of animal life.

The powers of the mind disappear along with those of the senses. The imagination and the memory are extinguished; the latter, however, under striking circumstances. The old man forgets, in an instant, what was said to him, because his external senses, being weakened, do not confirm sufficiently the impression on his mind: he is, however, able to recollect the transactions of early life, and sometimes retains a vivid impression of them. He differs from the infant in this, that the latter forms his judgments from what is passing, whereas the former forms his from what has already past. Both are, therefore, liable to great errors; for, the accuracy of knowledge, in regard to things present, can only be obtained by comparing them rigidly with other things. Locomotion and voice also participate in the decline of the other organs of animal life; their powers are intrinsically weakened; besides which, a certain degree of inactivity is imposed on them by the previous decline of the brain and senses.

If we now consider that sleep retrenches about one-third of the whole duration of animal life; that nine months of it are first lost in gestation; and that the extinction of our senses is the inheritance of old age; it will be seen how great is the difference between the whole duration of animal, and of organic life.

It has been remarked by Bichat, that the idea of death is painful to us only because it terminates our animal life, or those functions which put us in relation with surrounding objects. This is the privation which plants terror and dismay on the borders of the tomb. It is not the pain of death that we fear, for many dying persons would willingly commute death for an uninterrupted series of bodily suffering. But if it were possible for a man to exist whose death would only affect the functions of organic life, as the circulation, digestion, and secretions, allowing the exércise of the senses and the mind to continue, this man would view with indifference the extinction of organic life; because he knows that the happiness of living is not attached to it, and that he would remain, after this partial death, still in a condition to appreciate all the delightful ties of existence.[1]

[1] For a detailed exposition of the phenomena of the Animal and of the Organic Functions, see Human Physiology, by Robley Dunglison, M. D., Professor, &c., Jefferson College. Principles of Human Physiology, by W. B. Carpenter, M. D. Elements of Physiology, by ditto; Phila. edition. And Elements of Physiology, by J. Müller, M. D., translated from the German by W. Baly. M. D., London, 1840; also the Philadelphia edition of the same, arranged by John Bell, M. D., 1843.

CHEMICAL COMPOSITION.

CHAPTER II.

Upon the death of the body, the liquids and tissues which compose it are, when submitted to decomposition by chemical process, found to consist of a number of elementary ingredients which are common to it and to inorganic bodies, and amount to about twenty.

These Chemical Elements, as ascertained up to the present day to exist in a state of health, are, oxygen, hydrogen, nitrogen, carbon, phosphorus, chlorine, sulphur, fluorine, potassium, sodium, calcium, magnesium, silicium, aluminium, iron, manganese, titanium, lead, and copper: also iodine and bromine, which are almost exclusively from marine plants and animals. The oxygen, hydrogen, nitrogen, carbon, and phosphorus of themselves make the principal mass of the solids and liquids. The calcium is found in great quantities in the bones in combination with phosphoric and carbonic acids; the other elements exist in much smaller proportions, there being but little more than a trace of them found upon the decomposition of any part. The metals and the metalloids are not in their pure state, but united to chlorine or in that of oxide combined with carbonic, phosphoric, or sulphuric acid. They may be detected in the ashes of most animal substances. The iron is considered generally as an essential ingredient in hematosin or the coloring principle of the blood, and in the pigmentum nigrum; it has been found also in the lens and in the hairs. The existence of arsenic was asserted by Raspail and Orfila, who considered it to be introduced in phosphoric aliments, which always contain a small quantity of it. This unexpected declaration, which must of course have a most important legal bearing in cases of imputed poisoning, has been contested by Flandin and Danger, who declare that what Raspail and Orfila consider as arsenical stains in their experiments, are equally produced by sulphate and phosphate of ammonia united to an animal substance.

The most diffused chemical elements are the oxygen, hydrogen,

nitrogen, and carbon: they are the most essential principles of organic matter, as two of them at least must be present in every such compound. The other inorganic substances are found in much smaller proportion, and seem to be merely incidental to animal organism so as to make out some physical condition, probably not absolutely essential to life. Among these the phosphate of lime holds a high rank from its making about fifty per cent. of the skeleton, and next to it is the carbonate of lime from its making about eleven or twelve per cent. of the same. The other incidental articles are found in very small fractional quantities, and appear more as matters of curiosity, than as striking contributions. The existence of some is even contested.

Between the above organized matters and the fully formed texture, there is an intermediate condition resulting from their combination into a series of organic compounds, called proximate principles or organizable substances. These exist in the Embryo, and are also obtained in the first stages of chemical analysis. The most abundant of them are Protein, Albumen, Fibrin, Casein, and Colla or Gelatin; but there are many others in comparatively small quantities, the traits of which will be presented in place.

The manner of combination of the simple chemical elements to form the above organic compounds, is not yet settled by Chemists. Some consider them as equally united, and view the organic compounds as ternary or quaternary in degree; others hold that two or three of the elements form a compound radical, to which is united another so as to form a binary compound. The idea may be illustrated from inorganic Chemistry. Ether is formed by four atoms of carbon, five of hydrogen, and one of oxygen, the first two make a hypothetical radical called Ethyl, to which is united the one atom of oxygen; ether is thus an oxide of Ethyl, and the formula of its composition is Carbon, 4; Hydrogen, 5; + Oxygen, 1.

In organic substances, it is to be remarked that a union limited to two simple chemical elements is very rare, the almost universal rule being a compound radical of two or more substances united to an additional one. These organized unions of chemical elements are remarkable, too, for the facility of their dissolution, both during the living and the dead state.

Such obscurity prevails, however, on the real nature or condition of these organic combinations of chemical elements, that their reproduction in the laboratory by means purely scientific has scarcely advanced at all. The examples at present are limited to the formation by Wöhler of urea, from the cyanate of ammonia, in depriving it of a little ammonia by the influence of heat;—to allantoin, which is analogous to urea;—and to formic acid, which has likewise been elaborated by chemistry alone.

The organic compounds of animals are found to a large extent also in vegetables. The first elaboration from the inorganic state occurring in the latter renders them, therefore, highly suitable as food for man, the transition or modification being an inconsiderable one from the vegetable to the animal condition. The blood is the grand reservoir for the introduction and distribution of these organic compounds, each of which has its utility, so that neither albumen, gelatin, casein, nor fibrin alone will sustain life.

Of substances, the result of organization and of a character essential to it is Protein, which is the base of all albuminous bodies both in the animal and vegetable kingdom. It exists in fact in every tissue of the animal and of the vegetable fabric, being found dissolved in their fluids and condensed in their solids. It may be obtained by dissolving boiled albumen in a weak solution of caustic alkali, and then precipitating by the addition of an acid. The protein thus treated falls under the form of grayish-white flakes. When starch is washed from wheat flour, so as to leave merely the gluten, the latter treated by the above process yields also protein. The protein obtained in both cases appears to be identical in its sensible and in its chemical properties; it is also made soluble by an alkali and precipitated by an acid. It is hence seen that the transition from the vegetable to the animal form of matter is one of comparative simplicity. Protein is found abundantly in albumen, fibrin, casein, &c., united to a small quantity of sulphur, of phosphorus, or of salts, from which it is easily freed by certain chemical processes, the formulæ for which may be readily found.[1] In a humid state, this substance is gelatinous, insipid, inodorous. It is insoluble in water, alcohol, or ether. When dried, it is brown, hard, and fragile. When pulverized, it makes a yellow, amber-colored powder. It attracts moisture from the air, and when placed in water, swells up and resumes its first condition. On chemical analysis, it is found to be composed, in a hundred parts, of nitrogen 16.01, carbon 55.29, hydrogen 7, oxygen 21.70.

Albumen is the most universal of the modifications of protein. A striking example of it is the white of an egg, where it is collected into a large agglomerated mass, but it is also found in the serum of the chyle, of the lymph, and of the blood, in the serosity of serous cavities, in pus, in pathological secretions, and in the greater part of the liquids secreted from the blood. Whatever tissue one examines, a proportion

[1] See Henle.—Encyclop. Anat. vol. vi.—Simon's Animal Chemistry, Philad. edition, 1846.

of albumen is always found in it, and it is also one of the constituent principles of the brain and of the nerves. Its natural state is one of fluidity, but it is easily evaporated to dryness, and then forms a brilliant transparent mass of a yellowish color. It is rendered firm or coagulated by heat, most of the acids, and by many of the neutral salts. Its natural disposition is to remain fluid or semi-fluid; it is only when under chemical influences that it solidifies. It is so nearly allied to protein, that, according to Mulder, it differs from it only by a very small introduction of phosphorus and of sulphur into it, both together making but one part in a hundred.

Fibrin, another of the modifications of protein, is also found in the blood, the lymph, the chyle, the serosity of serous cavities, and is remarkable for the quantity which is thrown out upon inflamed surfaces and in inflamed tissues. It constitutes the base of the muscular system. It resembles exactly in appearance albumen, and the principal characteristic distinction from it is that of coagulating spontaneously. The blood of asphyxiated persons, of animals dead from fatigue, of certain poisoned individuals, and of such as die of hemorrhage from trivial wounds, does not coagulate. It is hence inferred that, in such cases, the fibrin does not exist, for by some vital process it has disappeared.

Under chemical analysis, it seems to be almost the same with albumen; in Mulder's experiments, it contained a little more sulphur, with a trifling variation in the quantity of the other ingredients. It contracts with acids, neutral salts, and different bases, the same combinations with albumen. The most remarkable chemical difference between the two is their habit in regard to oxygenated water. Chlorohydric acid makes a violet color with albumen—and an indigo blue with fibrin.

Casein, another of the products of protein, is found principally in milk, but is not confined to it, as it exists also in the blood, the saliva, the bile, the pancreatic juice, in pus, in tuberculous matter, and elsewhere, also in vegetables.

There are several processes known to Chemistry for obtaining casein. One of the most simple is that of Mulder, who adds acetic acid to milk, whereby the casein is precipitated, washes the precipitate in pure water repeatedly, squeezes the water out on each occasion, and afterwards removes the grease with boiling alcohol.

Dissolved in water, casein is of a pale yellow and of a consistence somewhat mucilaginous. On being evaporated, it exhales the odor of milk, and covers itself with a white pellicle which upon being removed is renewed. On being perfectly dried, it forms a mass of a yellow amber color, easily reduced to powder, and which attracts the moisture of

the atmosphere. In the humid or dissolved state, the addition of alcohol makes it opaque, and to resemble coagulated albumen, this is produced by the abstraction of its water. It is soluble to a small extent in boiling alcohol, and from that state of solution it may be extracted without any change of its properties.

The analogy of casein with albumen and fibrin is very close in many respects, and especially in regard to its power of coagulation, or capacity to change its state, so that it is no longer soluble in water.

Casein is coagulated by heat, by alcohol, by acids, and by rennet or the stomach of young animals. In boiled milk, the skin or pellicle which forms upon its surface is coagulated cheese. Alcohol precipitates it by abstracting the water which held it in solution. Many of the acids coagulate it freely, and notably the lactic acid which is produced from the sugar of milk, when the milk sours. Sugar of lead is a powerful coagulator of the same. The modus agendi of rennet or the dried stomach of young animals, in coagulating casein or milk, is as yet inexplicable. Its influence, however, in this respect is truly remarkable. Berzelius coagulated 1800 parts of milk with only one of rennet, and found that the latter had lost only six per cent. of its weight. It is ascertained by experiment that pure casein dissolved in water is not coagulated by rennet, but as the latter has that power upon casein dissolved in milk, it is hence suggested by Henle[1] as possible that the rennet only acts indirectly by the conversion of the sugar of milk into lactic acid.

Cheese which is prepared by rennet alone is called sweet cheese, and when prepared by lactic acid it is called acid cheese. It is supposed that it exists to a limited extent already coagulated in fresh milk, inasmuch as the envelopes of the globules of milk appear under the microscope to be insoluble casein.

Common cheese is a composition of dried casein and of butter. Pure casein, according to Mulder, contains in one hundred grains nitrogen 15.95; carbon 55.10; hydrogen 6.97; oxygen 21.62, and sulphur 0.36. Casein contains a quantity of phosphate of lime amounting indeed to $6\frac{24}{100}$ per cent., the presence of which is of the greatest importance for the nutrition of infants and for the formation of bone.

Pepsin is another combination of protein, and was discovered by Schwann in 1836. It is formed and found in the cells of the follicles and of the solid glands of the stomach, and may be obtained by macerating the mucous membrane of the stomach of an animal in distilled

[1] Henle, loc. cit. p. 46.

water. A solution thus made may be precipitated by basic acetate of lead, and afterwards separated from the lead by a particular process. This pepsin, when largely diluted with water and mixed with a small quantity of acid, constitutes an artificial gastric juice which dissolves albumen in six or eight hours; it has the same effect upon cartilage and upon cellular substance. It resembles very much albumen, but, unlike it, cannot be precipitated from its combinations with acids by the ferrocyanate of potash.

There are some substances in the composition of the body which, according to Professor Henle, ought not to be considered as belonging to its immediate materials. They are Globulin, Spermatin, Mucus, Dacryolin or the matter of the Tears; and the Horn-like productions.

Globulin. This material exists in the blood, and is the name given by Berzelius to a residuum of it obtained in a particular way. By diluting with water the red globules of the blood, they become transparent, swell up, and at last disappear, seeming to have been dissolved; but they may in fact be brought into view again by Iodine, which renders them opaque, thereby showing that the coloring matter may be extracted by water, and still leave the globules behind. By evaporating to dryness blood diluted with water, if alcohol be added, the coloring matter will be taken up by the alcohol, and the globules will be left; this residuum then is the *globulin* of Berzelius, and the coloring matter dissolved by the alcohol is the *hæmatosin.*

Globulin, upon trial by chemical analysis, is almost identical with albumen, and seems to be such in reality; it is, therefore, upon good grounds placed by Mulder among the combinations of protein. It is formed by the capsule of the blood-disks, with perhaps the nuclei. When extracted, according to the process of Lecanu, with sulphuric acid, its analysis furnishes the following parts: nitrogen 15.70; carbon 54.11; hydrogen 7.17; oxygen 20.52; sulphuric acid 2.50, which corresponds nearly with four atoms of protein to one of anhydrous acid.

Spermatin is a fluid derived from the semen of animals. At the noment of obtaining the semen in a fresh state, it is placed in alcohol, upon which it contracts in a few minutes an opaline color, and forms a clot like a pack thread, collected into a small bundle or hank. It may be dried in this state, when it forms a bunch of filaments of the color of snow. The article thus coagulated constitutes the spermatin of Berzelius, of Vauquelin, and of John, by the last two of whom it was discovered. It may be identified by certain characters or habitudes in regard to water, mentioned by Berzelius.

This fluid shows, under the influence of chemical agents, a close analogy with albumen. An analysis of it, however, must, to a large degree, be inconclusive, as the seminal fluid from which it is obtained is a mixture of the secretion of the testicles, of the vesiculæ seminales, of the prostate, of the glands of Cowper and of the urethra, besides containing scales of epithelium, corpuscles of mucus, and spermatic animalcules.

Mucus. Heretofore everything has been considered mucus which came from the surface of a mucous membrane excepting certain secretions of a decidedly specific character, as the saliva, the bile, the urine, and a few more. It is now, however, ascertained that, in the fluid commonly called mucus, there are at least three dissimilar constituents, to wit:—the waste of the epidermic mucous membrane, pus, and the mucous secretion itself.

The epidermic waste, or molt, resembles the scaly exfoliation which is incessantly in progress from the cuticle; and is formed by the desquamation of the superior layers, which, as they fall off, are succeeded by others. These scales are washed off by the fluid secretions of the part, and make to the mucous membrane a glairy coating, which is easily removed by scraping and by a stream of water. The pus is found in catarrh, coryza, blennorrhagia, fluor albus, and diarrhœa; and is formed from a liquid mixed with granules of a certain kind, coming from beneath the Epidermis of the mucous membranes. The mucous secretion is the product of the muciparous glands, and is for the mucous membranes what the perspiration is for the skin. It also is considered to be elaborated by the epithelial cells of mucous membranes, which in this process are constantly liquefying or bursting open.

Mucus from the nose, according to the analysis of Berzelius, consists in Mucin essentially	5.33
An extract soluble in alcohol and an alkaline lactate	0.30
Chloride of Soda and of Potash	0.56
An extract soluble in water, with traces of albumen and of a phosphate	0.35
Soda	0.09
Water	93.37
	100.00

Lachrymal Matter or Dacryolin. This is found as a residuum upon the evaporation of the tears in the open air. In this condition, it forms

a yellow and insoluble mucus, which neither heat nor acids coagulate. Fourcroy and Vauquelin find in it one per cent. of a solid substance seeming to be chloride of soda principally; and the remainder of this one per cent. is probably mucus and the scaly molt of the epithelium.

The Horn-like tissues, made of Keratin, are represented by the nails, the hair, and the epidermis. It was once supposed that they were formed from a fluid which dried up, but it is now known that in the case of each one, the primordial state is that of a cell, with a contained substance and a nucleus; and that it is an aggregation of such cells in a collapsed state, but adhering to one another, which constitutes the substances above alluded to.

The cells or scales of the epidermis are held together by an intermediate substance which dissolves in weak acids, and allows the scales to separate and float about, giving to them the fallacious appearance of being dissolved also.

Extractiform Substances.

After removal of the combinations of protein from animal matter, a nitrogenous organic residuum still remains mixed up with certain salts as lactates, chlorides, phosphates, and sulphates. What remains upon the separation of the salts by their appropriate solvents constitutes the Extractive Matter. Animal Extractive is very generally diffused in the tissues and humors of the body, but is found in greater abundance than elsewhere in the muscular flesh. This matter is readily obtained by steeping a part in aqueous alcohol, and then evaporating the latter entirely. If pure alcohol be poured upon this dry residuum, it removes from it a substance called the alcoholic extract, and what is left constitutes the aqueous extract, being soluble alone in water, and constituting what Thenard has called Osmazome (from Οσμη smell, and ζωμος soup); it is found abundantly in soups or bouillons, and in them is mixed with gelatin in the proportion of one part to seven of gelatin. It is the osmazome which gives flavor specifically to soups and meats. The extractive matter presents itself in several soluble forms; one, the *water extract*, is soluble in water but not in dilute alcohol; another is soluble in dilute but not in anhydrous alcohol; it is the *spirit* extract: a third, the *alcoholic extract*, is soluble in water, in dilute alcohol, and in anhydrous alcohol.

The extractiform substances show themselves under several modifications when tried by chemical tests; the processes whereby they may be detected are set forth in the works on organic chemistry.[1] One is

[1] See Henle. Also Simon, on Animal Chemistry.

called Ptyalin, from its being found in the salivary secretion; another Kreatin, from its being found in the liquids of meat. There are also several others which may be distinguished by different chemical agents.

Glue, or Colla.

Glue may be obtained from many animal tissues, but never exists in them in that state, and is produced by boiling them in water. The substances most productive of it are bones, cartilages, tendons, cellular tissue, and ligamentous matter. The tendons and true ligaments are so prone to this transformation, that they yield a weight of glue equal to their own weight, both being dry.

In the process of producing glue by the action of boiling water, there is neither a disengagement of gas nor an absorption of any of the constituents of the atmosphere. Acids, much diluted, favor the process. The substances which yield glue in the fully organized body, if treated in the same way during the earlier periods of development, produce what is called Pyin, a matter differing from glue. The common characters of glue are so well known as not to require a description on the present occasion: its chemical analysis, according to Mulder, yields, in one hundred parts, nitrogen 18.350; carbon 50.048; hydrogen 6.477, and oxygen 25.125. It has also a very small quantity of phosphate of lime in it.

Chondrin.

Chondrin resembles in many respects glue, and was first discovered and designated by J. Muller.[1] It is obtained by boiling in water the cartilaginous rudiments of bones, the articular cartilages, the fibro-cartilages of the nose, ear, larynx, trachea, and some other parts, as the cartilages of the ribs. It requires a more protracted boiling than common glue to produce it, and is the base of the permanent cartilages. It is precipitated from solution by alum, sulphate of alumina, acetic acid, and acetate of lead. Mulder's analysis showed in its composition nitrogen 14.44; carbon 49.56; hydrogen 6.63; oxygen 28.59; sulphur 0.38. Like glue, it contains about 6 per cent. of inorganic matter, chiefly phosphate of lime.

Pyin.

Pyin, discovered by Gueterbock, in pus, whence its name, is found also elsewhere, as in mucus, in tuberculous matter, in granulations, in

[1] Elem. Physiol. vol. i. p. 390.

false membranes of a recent date, in the skin of a fœtus, in condylomatous productions, and, in fine, wherever there is a cellular substance imperfectly developed. It is obtained by adding alcohol to pus, which precipitates the pyin with albumen; it may then be separated from the latter by water. The principal test for it is alum, which precipitates it in flocculi from a state of solution.

Hæmatin, or Hæmatosin.

Hæmatin is the coloring matter of the blood, and is found in the blood-disks or globules, though, under certain circumstances, it is free in the liquor sanguinis or the fluid part. It is thought that, in some certain states of the blood, the blood-disks being formed as they are of a vesicular envelop and a contained fluid, when the liquor sanguinis is too much inspissated some of the fluid of the blood-disks leaves them by exosmosis and joins the liquor sanguinis, the vesicle becoming somewhat collapsed; and on the contrary, if the liquor sanguinis be too fluid, the vesicles absorb some of this fluid and become turgescent. While in the former process, the solid constituent of the blood-disks, as the hæmatin, passes outwardly and may become mixed with the liquor sanguinis.

Pure hæmatin may be obtained by several proceedings known to the operative chemist, as through the reaction of alcohol, of ether, and of sulphuric acid. According to Muller, its chemical composition, in one hundred parts, is nitrogen 10.54; carbon 66.9; hydrogen 5.30; oxygen 11.01; iron 6.66. In a dried state, it has a dark-brown color, with a few brilliant points, and it is insipid and inodorous.

Bile.

This secretion is formed by a resin, according to Thenard, of a green color, not very soluble in water and completely soluble in alcohol. It also contains Picromel,[1] or a biliary sugar. This is colorless and inodorous, has a sweet taste which endures for some time in the mouth, and is also in a slight degree bitter. In addition to the preceding constituents of bile, there are Taurin, Cholic acid, and a coloring matter. In a recent analysis of the bile, by Berzelius, he has been induced to believe that the principal element of bile is a substance which he calls Bilin, easy to decompose, and by the aid of acids convertible into several other bodies.

[1] Called from its bitter sweet taste.

Urea and the Uric Acid.

Urea is found principally in the urine. It is also in the blood and in the secretions from it when the function of the kidneys has been invaded either by disease or by the ablation of these organs.

It is readily obtained by evaporating the urine to a syrup, then adding nitric acid to it, so as to make a nitrate of urea. The nitric acid may afterwards be detached by carbonate of barytes, and the urea being then dissolved in alcohol, the latter is driven off by evaporation.

Uric acid is found in the urine of carnivorous animals, and also in urinary and in arthritic calculi. The urine of serpents and of birds is formed almost wholly from the urate of ammonia. This salt is precipitated in a state almost perfectly pure from the human urine by the influence of a low temperature. The precipitate is at first powdery and gray, the color afterwards changes to a pale rose hue, and by drying, it assumes the form of scales, which are the smaller as the acid approaches a pure state.

The preceding substances enumerated and described as Protein and its products, also the Extractiform Substances, the Collin, or Gluey ones, Hæmatin, the constituents of Bile, Urea and Uric acid, are all distinguished by a large proportion of nitrogen in their chemical composition.

We have next to take into consideration certain animal matters, which are destitute naturally of Nitrogen; these are Sugar of Milk; Lactic acid; Saponifiable Fats; the Non-Saponifiable Fats; Fatty Bases, and Fatty Acids.

Sugar of Milk.

Sugar of Milk is found in the milk of woman and in that of the females of all mammiferous animals. In some cases where the secretion of the mamma has been suppressed, it has been found, or, at least, supposed to be in the fluids, secreted from the intestines or deposited in the peritoneal cavity. A case of the latter kind occurred to Schreger in the year 1800.[1]

It makes about two-fifths of the solid residuum of milk when this fluid has been evaporated to dryness, and may be obtained by depriving the milk of its butter and cheesy matter, and then evaporating it to the consistence of a syrup. When it gets cool the saccharine matter is

[1] Encyclop. Anat. vol. vi. p. 100.

deposited in crystals, and it may then be purified by successive solutions followed by crystallizations.

The specific gravity of sugar of milk is 1.543. Its crystals are four-sided prisms, having a lamellar arrangement, and ending in pyramids with four faces. It is much harder than sugar candy, has a moderately sweet taste, and one which is somewhat gravelly. It is soluble in about six parts of cold water, but does not dissolve in pure alcohol or in ether. The properties of it are somewhat different when taken from the human female and from the cow. Its concentrated aqueous solution turns spontaneously into lactic acid. Its elements, according to Liebig, are 12 atoms of Carbon, 24 of Hydrogen, and 2 of Oxygen. Various compounds are formed by treating it with chlorine, sulphuric acid, nitric acid, and other articles.

Lactic Acid.

Lactic Acid exists either free or in combination with different bases, in all the liquids and secretions of the body. In the free state, it is found in meat, in perspiration, in urine, and in milk. The bases with which it is in combination are soda, potash, lime, magnesia, ammonia, and urea. It is not only obtained from animal matter, but is produced in the fermentation of certain vegetables which produce starch and sugar.

The process for getting it from milk is as follows: A quantity of sour whey is to be evaporated to one-sixth of its weight, and then filtered. The phosphoric acid in it is then precipitated by chalk, and afterwards the excess of the chalk is to be corrected by oxalic acid. The liquor is then filtered again, the fluid part of it is evaporated, the lactic acid is then taken up by alcohol which leaves the sugar of milk. The alcohol is then to be evaporated, and the residuum is Lactic Acid. To purify it, however, perfectly, requires some other steps well known to chemists.

The lactic acid does not continue in the dry or anhydrous state, unless in combination with some base. When in the pure hydrated condition, it forms a colorless syrup, extremely acid, without smell, and having a specific gravity of 1.215. It is only dissolved to a very small extent in ether, but has no limits as regards water and alcohol. It coagulates albumen and casein, and its action is much accelerated on them by the assistance of heat. It was formerly confounded with acetic acid, but the difference is now well established in its want of volatility and of odor.

Lactic acid dissolves phosphate of lime very rapidly, by which quality is explained the quantity of this salt held in solution by milk, urine,

and other secretions. It has also been suggested by Marchand that the presence of an excessive quantity of this acid in the system causes a softening of the skeleton by preventing the deposit of phosphate of lime into the bones, and also dissolving that which already exists in them. Its atomic proportions are, Carbon 6, Hydrogen 10, Oxygen 5.

It is kept very conveniently in the form of lactate of barytes, or of lead, and forms with these bases a mass which resembles gum. Being superior in strength to acetic acid, it drives it from its combinations. Boiled in strong nitric acid, the latter acid seizes to some extent upon its oxygen, and produces oxalic acid.

Fatty Substances.

These productions of the animal body are destitute of nitrogen, and, as a common character, are insoluble in water, but soluble in hot alcohol and in ether. Some of them are saponifiable or capable of being converted into soap by union with an alkali; the same also unite readily with oxides of lead, so as to form plasters. This habit is in virtue of an acid existing in them, and which, being naturally united to a base, leaves that base and attaches itself to another, as the alkali or the lead. The acids and the bases themselves are oxides of compound radicals, supposed to be carburets of hydrogen.

Another series of fatty bodies cannot be converted into soap, and there is a doubt among chemists how they ought to be classed, whether among the fats which have a base, or as neuter organic matters. Among these peculiar organisms are Cholesterin and Serolin.

Cholesterin is found in bile, hence its name ; also in the blood, and in the medullary nervous matter ; it is also observed in the secretions, in morbid tissues, in cysts, in hydatids, in the water of dropsy, in medullary fungi and in other tumors.

Cholesterin, in its pure state, crystallizes in laminæ, of a brilliant mother-of-pearl color, soft to the touch and sometimes very large. It is inodorous and insipid, dissolves readily in hot alcohol or ether, but not in water. It may be obtained from biliary calculi by boiling them in water, and afterwards in alcohol; when the latter cools, the cholesterin is separated by crystallization. Its chemical components are carbon 85.095, hydrogen 11.880, oxygen 3.025. Treated with nitric acid, it forms cholesteric acid.

Serolin is so called from its being obtained from the blood; an original observation of Boudet. It may be procured by boiling dried blood in alcohol; it separates from the latter on its cooling, and floats about in

flocculi of a pearl color, of a fatty feel, and acting neither after the manner of acids nor of alkalies. When examined by the microscope, it is seen to consist in filaments, which are swollen out in a globular form from place to place. It is susceptible of sublimation almost without any alteration.

Of the Saponifiable Fats.

There are three substances which perform the part of base to animal fat: glycerin, the oxide of cetyle, and cerain. The first forms the base of human fat, and is more universally diffused in the animal kingdom; the second exists in spermaceti; and the third in wax.

Glycerin is separated from fat in the act of the latter forming soap with an alkali; but it may be obtained in the highest purity by boiling an oxide of lead in fat; the acid of the latter attaches itself to the lead, and the glycerin is left free, being dissolved in the water, from which it may be disengaged and purified by a particular process.

Glycerin is a clear liquor, somewhat yellow, without odor and somewhat sweet: it is very soluble in water or alcohol; not soluble in ether. It dissolves readily iodine, the vegetable acids, the deliquescent salts, the sulphate of soda, of potash, of copper, nitrate of silver, and many other articles.

Glycerin being the base of human fat, the acids which are found in combination with it are the stearic, margaric, and oleic; and the result of such combinations forms the fatty matters called stearin, margarin, and olein. Butter has also its own peculiarities in being formed of glycerin, in union with butyric, capric, and caproic acids; and even the cerebral matter presents a peculiar acid united to glycerin, and called by Fremy the cerebric acid, and an oleo-phosphoric acid.

The Stearic and Margaric acids are obtained pure by a process which is complicated and prolonged; they are very feeble, but at an elevated temperature drive carbonic acid from its combinations. Their union with glycerin makes the principal part of the fat of the human body.

The Oleic acid is an oleaginous liquor, of a clear yellow: it is very acid, and has a rancid smell and taste. It is insoluble in water, but very soluble in alcohol. The olein which it forms by union with glycerin is in a fluid state naturally, but is kept so at degrees of temperature varying in the different animals.

The above acid and basic constituents of animal fats are seldom found insulated, being almost always under the combinations alluded to above; a departure from this rule exists occasionally with the acids, but never

with the base or glycerin. The fats under the form of stearin, margarin, and olein are blended in the adipose tissue of the cellular substance, and in the fat of the bones or marrow as it is called. The consistence of the fat depends upon their relative quantity in it. Thus Olein predominates in oil or the fluid part of fat, it commonly not being in great quantity in the human subject; but there are individuals of enormous obesity in whom its proportion is excessive, so that, in making a necropsy of such in warm weather, the oil runs all about. Margarin is next in consistence, and forms lard, such as is found in the hog and in the bear. Stearin forms suet, and is found to a remarkable degree in the fat of the sheep, and of the bullock.

Fat, besides being in the cellular substance and in bones, prevails to a great extent elsewhere in the human body, as in the composition of the brain. It is found in chyle, blood, pus, bile, milk, and sometimes in urine. In milk and chyle its globules are in little vesicles. Its different modifications exist in the vegetable kingdom; as stearin in the cocoa-nut butter; margarin in palm oil; and olein in flax-seed oil, and many others.

HISTOGENY.[1]

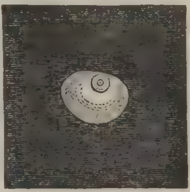
OR THE

ORIGIN OF THE ELEMENTARY TISSUES.

CHAPTER III.

In animals, we find, at an early period of their evolution, and during their whole life, corpuscles so exceedingly fine as to require a microscope to see them distinctly. They have a certain characteristic shape and are called elementary cells, primitive cells, and also nucleated cells, from the existence of a small point or nucleus within them. They are, in fact, vesicles with parietes extremely attenuated, contain a fluid of some kind, occasionally granular; and have attached to their walls or lying loosely a smaller body, which is called the kernel or Nucleus, and also Cytoblast, in the language of Schwann.[3] The nucleus presents, on most occasions, one or two spots or points, of a regularly rounded shape, and which go under the name of Nucleoli. The nucleus itself is of a rounded or ovoidal shape, somewhat flattened, is colorless or of a reddish yellow, smooth, or granular like a raspberry, in which case its nucleoli are imperceptible. Its diameter is from the

Fig. 1.



Primary organic cell, showing the cell-membrane, the nucleus, and the nucleolus.

[1] From Ιστος texture, and γενεσις generation.

[2] From Κυτος cell, and βλαςτος, germ.

[3] The Cytoblast or Cell-germ had been long understood as an essential and generally diffused constituent of vegetable structures, when, in 1838, its especial importance in the development of vegetables was declared by Schleiden. (See Müller's Archives, 1838.) After that Valentin (see Wagner's Elements of Physiology, Lond. 1841, translated by Willis), and subsequently Schwann in 1839 (see Micros. Inquir., &c., Berlin, 1839) declared the identity in office and in structure of the cell-germ in both vegetables and animals. This analogy of structure is so close that the description of one may be applied almost exactly to the other, by the admission of the most approved microscopists. (See Gerber, Gen. Anat. Lond. 1842, p. 40.)

two to the four-thousandth part of a line, or from the $\frac{1}{24000}$ to the $\frac{1}{8000}$ of an inch. This nucleus appears sometimes itself to be made out of a membranous envelop with a contained fluid.

The above elementary cells, at an early period of their existence, are soluble in acetic acid, the nuclei being left behind; the nucleoli are to the same degree indestructible by this agency. The nucleoli are of a doubtful character, it being unsettled whether they are stains, globules, lacunæ, or vesicles in the nuclei. Schwann says that they are upon the outside of the nuclei in the round cells, and on the inside of the nuclei of the concave cells.

The walls of primary cells are homogeneous or amorphous, *i. e.* they appear to have extension with the least conceivable thickness, are perfectly smooth under the highest magnifying powers, and have neither filaments nor granulations, nor anything else indicative of an interrupted surface. The best idea of them would, perhaps, be derived from the inspection of a very small soap bubble.

The elementary cells are situated in a substance also amorphous, and called by Schwann Cytoblastema, and which executes the office of an intercellular substance. When this intercellular substance is liquid, the primary cells float freely about in it, as in the case of the blood; but when the cytoblastema has more consistence, the cells are fixed to their places, and even glued together with some tenacity; with a force, in fact, requiring a special solvent to free them.

The progress of these primary cells may be studied in the incubated egg, in the tissues of the body which are in a constant state of reproduction, as the nails and hairs, and also in the exudations of fibrin which occur on inflamed surfaces. The vegetable kingdom, also, according to Schwann, presents analogies or repetitions of the process precisely identical with what occurs in the animal kingdom.

The phenomena are as follow. An amorphous fluid by some internal change becomes granular. This amorphous fluid is gum in a plant, but albumen in an animal. The first perceptible change from this condition of uniform and unclouded transparency is the appearance of numerous extremely minute granules, which make the fluid turbid. This state having remained for a short time, certain granules larger and more defined than the others are seen, and appear to augment by collecting the finer ones around them. This is the first state of nucleus, or cytoblast, or cell-germ, as it is also called.[1] From the surface of

[1] The discovery of this germinal coagulation, as the first formative act, has been attributed to Schleiden, see Müller's Archives, 1838, and to Schwann, see Mikroskopische, &c., 1839. A much more ancient author may, however, be quoted with greater propriety in the following words, "Nonne sicut lac mulsisti me, sicut caseum me coagulasti? Hast thou not poured me out as milk, and curdled me like cheese?" Job x. 10.

each cytoblast a delicate membrane rises up in an attitude resembling that of a watch glass to the dial; this membrane increases in extent and magnitude, until it envelops the cytoblast so completely that the latter is seen merely as a nucleus on its wall. The consistence of the cell is for some time very soft, and occasionally it disappears from trifling disturbances, as a slight agitation in the surrounding fluid.

Fig. 2.

Plan representing the formation of a nucleus, and of a cell on the nucleus, according to Schleiden's view.

According to Schleiden, the function of the nucleus ends with the evolution of the cell, but others hold that the granules of which it is composed become the germinal points of other cells, to be developed within the original one.

The elementary granules being the first indications of a rule of form, or distinctly defined shape, the opinion is entertained, from the present state of our knowledge, that they are vesicles consisting in a small sphere or particle of fat, enveloped by a membrane. The existence of a membrane, though then invisible, would seem to be proved by the circumstance that the spherules are kept apart in this miniature state, but when they have augmented, then the exterior envelop is absolutely seen. The envelop itself is considered as a modification of Protein, and is soluble in acetic acid, upon which being done the granulations readily coalesce, and are easily dissolved in boiling ether or alcohol, which they had previously resisted.

The above modification of protein is, probably, albumen; and an observation bearing on this point was originally made by Ascherson—to wit: that albumen never fails to coagulate in a membranous form when it comes in contact with fat. Under this law a particle of grease cannot for a moment be in contact with albumen, without the latter being drawn over it in a membranous form. A drop of each of these substances in a fluid state, put in contact on a plane surface, exhibits instantaneously this phenomenon, in the formation of a delicate and elastic membrane around the fat, and which covers itself with numerous elegant folds. Oil and albumen, shaken in mass together, exhibit the same upon a larger scale. A decisive proof of the existence of the capsule of albumen thus formed, is that a process of exosmosis and of endosmosis occurs in its parietes, so that a fluid having an affinity for the oil makes the capsule expand or contract into wrinkles, according to circumstances,[1] upon its being brought into contact with the capsule.

This striking experiment has been seized upon by Henle to elucidate what occurs in the formation of living elementary granules. Fat and

[1] Encycl. Anat. p. 164, vol. vi.

the combinations of protein are incessantly introduced into the system by the action of the animal organism on aliments, so that they are found in the chyle, in the blood, and in all the fluids of the body. The fat on its formation becomes quickly surrounded by a film of albumen, so as to prevent its particles from collecting into masses of large size, and the particles thus situated may become elementary granules in being deposited in the texture of organs.

It is not, however, pretended that a process so purely physical as the formation of a film around a drop of fat gives all the explanations requisite for the understanding of a vital process; for an organic cell and an artificial one are as different from each other as a dead body is from a living one. Chance alone produces the resemblance, so far as it exists in form; the vital force of one makes afterwards an incomprehensible and unlimited difference.

It may here be remarked that the globules of fat, common to the fluids of the body, are kept when in a healthy state within certain limits of magnitude; and that in the case of pus, it is of a bad nature when the fat globules collect into large drops; hence the latter are seldom or never seen in pus of a good quality.

In the estimate of the sources of elementary cells, it may also be remarked, that there is another act of the animal body exhibiting some analogy. It is known, for instance, that fibrin, in coagulating, forms naturally a reticulated or cellular arrangement containing serum; in some cases even vesicles are thus produced, when a clot remains for some time in a living vessel or canal; and sometimes such vesicles are seen erecting themselves so as to be appended only by a pedicle. Henle has seen this assumed cellular arrangement containing serum, in polypi of the heart; in the membrane of croup; and in the plastic exudations of the womb, and of the intestinal canal. He concludes, therefore, that many hydatids come from such cells taking on a spontaneous growth. Dujarden has observed a similar process to the above in an exudation, which he calls *Sarcode*, coming from the bodies of dying infusory animalcules, and from the fragments of the higher animals. In this matrix are generated small insulated globules, that finally acquire a larger size at the expense of the matrix, which ultimately collapses, and is reduced to a very small residuary matter.[1]

Another hypothesis in histogeny is that of Raspail and of Schwann, who see in the elementary cells phenomena analogous to the formation of crystals in inorganic matter; the difference being that these organic crystals execute an imbibition of new molecules for their growth, while inorganic crystals grow merely by superposition. The points in detail

[1] Encycl. Anat. vol. vi. p. 16.

of this theory are so much in the line of gratuitous assumption, that much remains yet to render it acceptable.

Upon the multiplication of cells depend the reproduction and growth of the body. In some cases these cells are secreted in succession from a matrix; which, in the case of the epidermis, the nails, and the hairs, is the cutis vera. Each cell in them is developed in an insulated manner, and reaches its perfect state by its formative force alone. This occurs in tissues having but an inferior degree of vitality as the above. But in the majority of instances, the formation of one cell depends upon the action of pre-existing cells. It becomes an act of generation, wherein the new cell forms at first an appendage to an older one; the older cells finally disappear and are succeeded in full by the new cells; and this act of succession in generations is constantly going on during the life of the individual. This process reduces animal life to an evolution of contemporaneous and intercurrent generations of monades: each generation parting with its vitality in behalf of proximate succeeding generations, but in such a way that the life of the whole system is continually kept up. In general death, the act of regeneration is of course universally arrested.

Fig. 3.

Oblique section of Epidermis, showing the progressive development of component cells.—*a*. Nuclei, resting upon the surface of the cutis vera. *f*. These nuclei are seen to be gradually developed into cells, at *b*, *c*, and *d*; and the cells are flattened into lamellæ, forming the exterior portion of the epidermis at *e*.

The generation of cells as above is produced in two ways, one called *exogenous* from its occurring in the form of an excrescence or sprout on the exterior of preceding cells. Henle considers this act to be confined to the lower conditions of vegetable life.[1] On the contrary, Müller asserts it as of common occurrence in many animal tissues. In this case the cytoblastema or matrix of the new cell is on the exterior of the older one. The other mode is called *endogenous*, because it occurs within the circle of the old cell from the cytoblastema which it contains. The most conclusive proof of the latter is presented in the development of the Embryo, at the expense of the granular contents of the yolk of an egg. From the observations of the German physiologists it appears, that in certain molluscous animals the first act of evolution of a germ is the appearance of three or four

Fig. 4.

Scheme from Dr. Barry, showing young cells growing within a larger one in concentric series. One of the young cells is represented as filled with a still younger generation.

[1] Encycl. Anat. vol. vi. p. 172.

globules; these contain others, which grow in their turn, and distend the preceding; then a third generation occurs within the walls of the second, and so on successively until a homogeneous mass of cells is formed, which shows almost completely the form of the young animal.[1] Morbid productions assist in throwing light upon this point of inquiry. Valentin has observed in carcinoma a cell containing two others, each provided with a nucleus. J. Müller has witnessed young cells enclosed in older ones in cases of medullary sarcoma and some other cancerous affections.

In healthy tissues the same experience exists, for example, in the formation of cartilage and in the growth of glands. The granules of mucus are nucleated cells; those of pus and lymph also. Schultz was the first to discover that the blood-disks or corpuscles are of the same description, the matter which gives them a color being contained within them.[2]

In the vegetable kingdom young cells are generated by partitions traversing the interior of the older cells: the divisions which occur in the interior of the yolk of an egg are considered as an analogy, in the animal kingdom, to this process, though with that exception, the examples are deficient.

As each tissue of the body can produce cells of an assimilated nature to itself, so when accidents occur to such tissues, as in the case of a ruptured bone or muscle, the ruptured ends take on a similar action for the repair of the accident. The proceeding is modified according to the tissue; if, however, in those accidents the ruptured ends be kept too far apart, the action does not extend to a sufficient distance, and the cure is incomplete, the intermediate substance not conforming to a proper nature. In most instances, common cellular substance supplies the deficiency. It is under this law that Henle has asserted that light and repeated congestions are followed by simple hypertrophy, as in the muscles and epidermis, while greater congestions produce degeneration, induration, and suppuration.

In the early state of the fœtus, we find nothing but cells. They are held together by a substance which is called *hyaline*, from its resemblance to glass, that is, being smooth, shining, destitute of fibres, and exactly homogeneous in its appearance. Occasionally this intercellular substance is granular, or even filamentous. The cells themselves, in the ulterior development of the being, undergo for the most part metamorphoses which finally bring them into the condition of the several tissues enumerated at the beginning of this treatise as representing the classification of Bichat. Some of the cells retain, however, perma-

[1] Encycl. Anat. vol. vi. p. 173. [2] Müller, Physiol. p. 1644.

nently their original character. The formation of cells is though, as previously remarked, not limited to any period of life, but is constantly going on, as these minute organic bodies are interposed in all the functions of life, being involved in the secretions, connected with nutrition, found floating in numbers in all the assimilated fluids, and participating largely in inflammatory actions.

One might infer from the simplicity of this inceptive step of an organized being, that is, the presence of a mere cell from which others are generated, either internally or externally, that wherever an organic compound, as protein, or any of its cognates existed, there would be a spontaneous evolution of animal life in it, without the aid of fecundation. This opinion has in fact had numerous supporters and is not destitute of advocates at the present day; but the progress of knowledge is revealing constantly so many exceedingly minute forms of animal and of vegetable life, that it leaves, as the strongest ground of inference, that in all cases of apparently spontaneous generation, ovula have been invisibly deposited in and around the matrix. Moreover, recent experiments show that neither vegetation nor animalcular evolution will be exhibited in fluids which have been subjected to such processes as must inevitably kill any germs which may have been deposited in them.

From the state then of nucleated cells, as described in the foregoing pages, all the tissues may be traced as they exist in the perfect and mature animal. The metamorphoses of the cell are found to have affected both its walls and the nucleus.

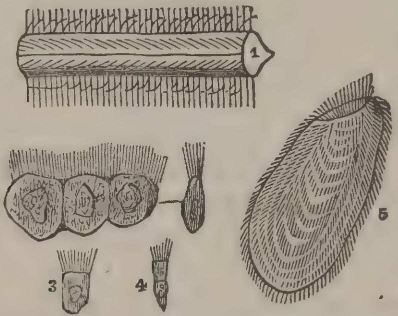
In some instances, the cells continue independent of each other, there being no disposition to coalesce; this habit is remarked in the case of the circulating fluids as in the corpuscles of the blood, in those of the lymph and the chyle, in the epidermis, some pigment membranes, and the fat cells. In certain cases, such cells grow largely; for example, a young elementary fat cell will be found at first only the $\frac{1}{4000}$th of a line in diameter and subsequently grows to be the $\frac{1}{400}$th of a line. The shape of cells is also modified very much by pressure; some are flattened, some are pentagonal or hexagonal, some cylindrical, some prismatic, some cuneiform or conical.

A very singular metamorphosis of certain cells is where they produce at one side, or at various points, small thread-like elongations or fringes, called Cilia, from their resemblance to the eyelashes. Such fringed cells are generally flattened, whatever may be their shape, whether pentagonal, cylindrical, or conoidal; and are placed upon free or non-adherent surfaces.

These Cilia, according to Purkinje and Valentin, are flattened, their

points being rounded off; some are fusiform; and their length is from about $\frac{1}{1000}$th to $\frac{1}{12300}$th of an inch.[1] They are disposed in rows of some regularity. During life, and for some time after its extinction, they have a sensible waving motion, resembling that of a field of wheat agitated by a steady breeze, each one bending forwards and back again, and having also a gyratory motion. The action of the cilia produces a current in the fluid contiguous to them, the course of which may be rendered very plain by mixing with the fluid particles of finely-powdered charcoal. The integrity of the cells, to which the cilia belong, is essential to this motion; for, if they become dry or altered by putrefaction or chemically, the cilia cease to play. The scrapings of the throat of a frog are well suited to this display of epithelial ciliary motion. On one occasion, the latter was seen to last for seventeen hours, in a frog. In a turtle's mouth, it was found to last for nine days after decapitation; in the trachea and lungs for thirteen days, and in the œsophagus for nineteen days.[2] It appears

Fig. 5.



Examples of Cilia :—1. Portion of a bar of the gill of the Sea-mussel, *Mytilus edulis*, showing cilia at rest and in motion. 2. Ciliated epithelium particles from the frog's mouth. 3. Ciliated epithelium particle from inner surface of human membrana tympani. 4. Ditto, ditto: from the human bronchial mucous membrane. 5. *Leucophrys patula*, a polygastric infusory animalcule: to show its surface covered with cilia, and the mouth surrounded by them.

to be entirely independent of muscular motion, as the removal of the brain and spinal marrow in frogs does not affect it, neither does the administration of hydrocyanic acid, opium, strychnine, belladonna, or electricity.

This phenomenon exists to a great extent in the animal kingdom. In man it has been observed upon the surface of the ventricles of the brain and upon the choroid plexus; upon the Schneiderian membrane, the soft palate, the pharynx, the Eustachian tube, extending to the cavity of the tympanum, upon the lining membrane of the frontal sphenoidal and maxillary sinuses; upon the lachrymal passages, upon

[1] Müller's Physiol. p. 859.

[2] Todd and Bowman, Physiol. Anat. p. 62, London, 1843.

the lining membrane of the larynx, trachea, and bronchial tubes, and upon the lining membrane of the uterus and of the Fallopian tubes.

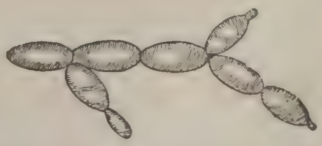
To resume, in regard to the metamorphoses of cells; they have a faculty of thickening their own walls, which is very perceptible in the cylindrical epithelial cells of the intestinal canal, and in the cells of cartilage. Such cells as are thickened by a deposit of internal stratifications present a striated appearance in their progress; and, in certain cases, the cell is entirely filled, becomes flattened and solid, and all distinction is lost between its parts, as occurs in the upper layers of the epithelium. (See Fig. 3.)

Another phenomenon attending the life of cells is their rupture or dehiscence and final disappearance. The corpuscles of the lymph and of blood are considered as examples of this. In the blood-disk upon the absorption of its nucleus, the investing membrane thins down, is more easily destroyed by chemical agents as it grows older, and finally ends by being dissolved wholly. The cells of glands, commonly called mucous granulations when they are evacuated whole, undergo the same process naturally. The dehiscence or partial destruction of cells makes them enter into free communication with other cells, or with the surface of the body, or with the cavities; being excretory ducts or otherwise, with which they are connected. It is said that such a dehiscence gives to the peripheral ends or origins of excretory ducts, as in the salivary glands and mammæ, their globular termination.

Cells are blended with contiguous ones by several modes of union. In one mode, their walls being thickened as explained above, they coalesce with adjoining cells similarly circumstanced, and with the intercellular substance, the cytoblastema: the cavities of the cells remaining all the time separate. Henle thinks it to be on this principle that ossific cartilages are developed; consequently, the bones themselves and the cement of the teeth.

In another mode of union, the cavities of the cells communicate freely, in consequence of the removal of their parietes where they come into contact. In some instances, they make a continuous tube in that way, from several of them being in the same line. In other instances, they are so grouped as to form a cluster of communicating cells. In other instances still, they are branched so as to make radiating communications.

Fig. 6.



Development of new cells from the outer wall of pre-existing cells.

There are several points of a very minute character connected with the development and transition stages of cells, and of their nuclei into tissues: such as their fusion with each other, their metamorphoses by the reception of the ingredients or organisms of the tissues respectively, and also their evolution into filaments and canals. The details cannot be very conveniently introduced on the present occasion, but they are subjects of deep interest and curiosity; for an exposition of which see the General Anatomy of the Tissues under their respective heads, and also the same by that very careful and distinguished observer, Professor Henle, in his work on the History of the Tissues.[1]

The foregoing observations on the primordial cells of the human body have their value established by the circumstance that the nutrition of a part consists in the growth of individual cells. The latter derive their nutriment from the organic compounds supplied by the blood, each set of cells making its selection upon the principle of a special affinity for some particular constituent of that fluid. Every cell is, therefore, to be considered as participating in the phenomena of life and of organization, by the influence which it exercises in its place. The modification of vital force, or the character precisely of that force, constitutes the problem of life, which, in the present state of the human mind, must be inexplicable. It is, indeed, an ultimate fact of Physiology, of an inscrutable character, an endowment of matter too subtle for human investigation.

[1] Encycl. Anat. Paris, 1843

SPECIAL

ANATOMY AND HISTOLOGY.

BOOK I.

PART I.

OF THE SKELETON.

THE skeleton is the bony framework of the human body; and, by its hardness and form, retains in proper shape the whole fabric; affords points for the attachment of muscles, and protects many of the viscera. Anatomists call the bones, along with their natural connections of ligaments, cartilages, and synovial membranes, a natural skeleton; and the bones only, but kept together by artificial means, an artificial skeleton.

The bones are inflexible, and in a recent state are of a dull white color, familiar to most persons from its being the same in animals; but they are made of an ivory whiteness by being properly macerated and prepared.

The regional division of the skeleton is into Head, Trunk, Superior or Thoracic, and Inferior or Abdominal Extremities.

If a vertical plane be passed from the top of the head downwards, through the middle of the skeleton, this plane will divide the latter into bilateral, or two equal portions, called, in common language, the right and the left side of the body. These two sides are perfectly alike in shape and size.[1] Some of the bones are found in this plane, being in-

[1] The exact harmony or symmetry of form and size, between the two sides of the body, as a general rule, is rather hypothetical than real in nature. It is a point of general notoriety, that the right side enjoys more force than the left, and this will be found attended with greater development. There are few persons that have not the face and the spine somewhat out of shape from the bones on one side growing larger than on the other, the right, commonly, prevailing over the left: hence we see a nose somewhat turned; and a spine curved, the convexity of which is to the right side, with the attendant consequences, on the position of the ribs, the scapulæ, and the sternum. This condition of false growth is exhibited in all degrees, from a deviation almost imperceptible to one amounting to deformity. The left side is said, also, to be more liable to diseases. Copious reports on these several subjects as well as on human stature, generally, at all ages, have been made by the French Anatomists; for a summary exposition of which, see Malgaigne, Anat. Chirurg. vol. i. chap. 1. Paris, 1838.

tersected by it into two equal parts or halves: others are somewhat removed from it, and are in pairs. This arrangement antagonizes the two sides of the body, and qualifies it for all its motions.

CHAPTER I.

HISTOLOGY OF THE BONES.

SECT. I.—NUMBER, TEXTURE.

THE number of the bones is commonly the same in every person of middle age; but they are less numerous then than in infancy, from several of them having been originally formed in pieces which coalesced afterwards. The farther fusion, in advanced life, of contiguous bones into each other, diminishes still more their number.

The situation of the bones varies; some are profound, while others approach very near to the surface of the body. They are, as stated, either symmetrical, that is, consist of two lateral portions precisely alike;—or else in pairs, having a perfect correspondence with each other. The symmetrical or bilateral bones are the frontal, the occipital, the sphenoidal, the ethmoidal, the vomer, the inferior maxillary, the hyoid, the spinal, and the sternal: and they are situated under the middle vertical plane of the body. The pairs are on the sides of the middle plane, more or less removed from it.

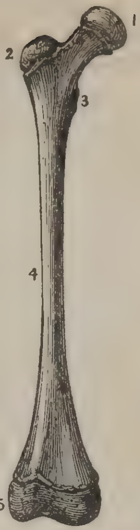
Bones are designated as the Long, the Broad, and the Thick. The Long bones (*ossa longa*) are those whose length prevails in great excess over their breadth; they are generally cylindrical or prismatic, and have their extremities enlarged for the purpose of articulating with adjoining bones. The Broad bones (*ossa lata*) are those whose breadth and length prevail largely over their thickness; they have their shapes diversified by muscular connection and by the forms of the viscera they contain. The Thick bones (*ossa crassa*) are such as have their several lines of measurement more nearly of a length; they are situated in the vertebral column, and in the hands and feet, and have their surfaces very irregular.

The bones present, on their periphery, eminences and cavities, a proper knowledge of which is of the greatest importance to the surgeon. The former are called apophyses or processes, and are extremely numerous and diversified: they serve for the origin and insertion of muscles; and for furnishing articular faces. The cavities are also numerous; some of them are superficial, and serve for articular surfaces; others for the origin of muscles; for the enlargement of other cavities, as those of the nose and ear; and for purposes which will be mentioned elsewhere.

The articular ends of the long bones are called Epiphyses, from their being formed from distinct points of ossification, whereas, the shaft of

the bone is its Diaphysis or body, being the part first formed. The epiphysis, therefore, as its name implies, grows upon the other. Many processes grow after the manner of epiphyses, from distinct points of ossification, though they are seldom called by the same appellation. This is the case with the trochanters of the os femoris, with the processes of the vertebræ, the crista of the ilium, and the tuber of the ischium.

Fig. 7.



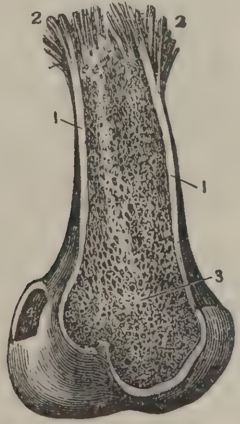
A young femur, showing, at 1, 2, 3, 5, the Epiphyses. 4. The Diaphysis. 2, 3 afterwards become Apophyses.

Near the centre of many bones, especially the long, a canal is formed which passes in an oblique direction, and transmits blood-vessels to their interior. There are also, at the extremities of the long bones, at the different points of the thick ones, and near the margins of the flat ones, a great many large orifices, which principally transmit veins: in addition to which, a minute inspection of any bone whatever, will show its whole surface studded with still smaller foramina, also for the purpose of transmitting both kinds of blood-vessels.

The density of bones is always well marked, and exceeds much that of other parts of the body. It is, however, variable in different bones, and in different places of the same bone; hence their substance has been divided into compact or cortical, and the cellular, of which the former is external and the latter internal.

The *Compact structure*, or *substance*, is formed of filaments and laminæ, which we find to be so closely in contact with each other, that

Fig. 8.



The texture of a bone as shown in a Femur, after maceration in dilute acid. 1, 1. The compact matter as usually seen. 2, 2. The same split, so as to show the longitudinal fibres composing it. 3. The internal cellular matter. 4. The bone seen under its articular cartilage.

the intervals between them are merely microscopical in the greater part of their extent: they become, however, more and more distinct, and

larger, near the internal surface. At the extremities of the long bones, the compact tissue is gradually blended with the cellular structure, or lost in it. Its filaments are generally longitudinal in the *cylindrical bones,* radiate from the centres of the *flat ones,* and are so blended

Fig. 9.

The filaments of the external surface of the compact structure of an os femoris treated by maceration in diluted muriatic acid, showing very minutely their course and general arrangement.

as to render it impossible to trace them in the *thick ones.* This disposition in the flat bones is much better seen in early life: subsequently, it becomes indistinct.

The *Cellular structure,* or *substance,* grows from the internal surface of the other, and is composed of filaments and small laminæ, which pass in every direction, by crossing, uniting, and separating. The cells, resulting from this arrangement, present a great diversity of form, size, and completion. They are filled with marrow, being hence called medullary cells, and communicate very freely with each other. The latter may be proved in the boiled bone, by the practicability of filling them all with quicksilver from any given point; and, indeed, by the injection of any matter sufficiently fluid to run. The communications between them are formed by deficiencies in their parietes, after the same manner that the cells of sponge open into each other. This structure does not exist in the earliest periods of ossification, when the bones are cartilaginous almost entirely, but develops itself during the deposit of calcareous matter. The manner of its formation is imperfectly understood, though it may possibly be the result of absorption, and it is not completed in the bones, originally consisting of several pieces, till these are consolidated into one.

The compact or cortical and the cellular structure present themselves under different circumstances in the three species of bones. The *compact* has a predominant thickness in the bodies or diaphyses of the long bones, and is accumulated in quantities particularly great in their

middle, which, from its position, is more exposed than their extremities to fracture from falls, blows, and violent muscular efforts. But as this texture approaches the extremities of the long bones, it is reduced to a very thin lamina, merely sufficient to enclose the cellular structure and to furnish a smooth articular face for the joints. The *cellular structure*, on the contrary, in the long bones, is most abundant in their extremities, constituting their bulk there, and is least so in their bodies. It is so scattered at the latter place as to leave a cylindrical canal in their middle, almost uninterrupted for some inches. This canal, cellular in its periphery, has its more interior parts traversed in every direction by an extremely delicate filamentous bony matter, which, from the fineness of its threads and the wide intervals between them, has been, not unaptly, compared to the meshes of a net, and is, therefore, spoken of especially under the name of the *reticulated or cancellated structure*

Fig. 10.

A longitudinal section of a Tibia, showing, 1. The compact structure. 2. The reticulated or cellular structure. 3. A transverse section of the femur, showing its compact substance, its internal cellular structure, and the medullary canal.

or tissue of the bones, in contradistinction to the cellular. It is formed on the same principle with the latter; and though the term, from that circumstance, has been rejected, upon high authority, as superfluous, it appears worthy of retention, as it expresses a fact of some importance. Too weak to contribute in an appreciable degree to the strength of the bone, the reticulated or cancellated tissue seems principally useful in supporting the marrow and in giving attachment to its membrane. The extremities of this cylindrical canal gradually disappear by becoming more and more cellular.

In the *flat* bones, the compact structure forms only their surface or periphery, and is of inconsiderable but generally uniform thickness; the space within is filled up with the cellular structure, which is rather more laminated than it is in the long bones.

In the *thick* bones, the compact structure forms their periphery also; but, generally, it is thinner than in the flat: their interior is likewise filled up by the cellular structure, and does not present differences of importance, from the ends of the long bones.

The lamellated state of bone is rendered more evident under the use of the microscope. In the long bones this lamellated structure is concentric in circles; but in the flat there is simply a superposition in parallel plates.

Fig. 11.

A view of the Concentric Lamellæ of the compact matter of a bone.

Where articular surfaces exist, the compact structure is particularly condensed and smooth, has no foramina for the transmission of blood-vessels, and is strictly adapted to the adhesion of the articular cartilage.

The compact tissue, particularly in the cylindrical bones, has in it a multitude of longitudinal canals, visible to the microscope, and some

Fig. 12.

Longitudinal section of compact substance showing Haversian canals magnified.

of them to the naked eye, which contain vessels and medullary matter. These canals, originally described by Clopton Havers,[1] run parallel with one another in the spaces between the laminæ, and give off small branches which pass through one or more laminæ, and anastomose with contiguous Haversian canals, thus forming a reticulated communication of osseous tubes which permeate the compact substance. They open externally and receive their blood-vessels from the periosteum, and internally merge into the cells of the cellular structure, from whose medullary membrane they likewise receive blood-vessels. Some of them are as large as the $\frac{1}{200}$th of an English inch, others as small as $\frac{1}{2500}$th, and they are about $\frac{1}{120}$th of an inch apart. They are, according to M. Béclard, about one-twentieth of a line in diameter, on an average; but are, generally, larger near the interior than the exterior surface of the bones, and have frequent lateral communications with the cellular structure, and with the external surface.

The Haversian canals being common to all bones, are uniformly formed of concentric circular laminæ. They are in fact miniature or extremely attenuated representations of what the great medullary canal is in the long bones, and seem to execute very much the same function in the accommodation of blood-vessels and fat. With their corresponding concentric laminæ each one is therefore a miniature, or subordinate bone, which for the advantage of a name may be called the Haversian Ossicle. As these vascular channels are very numerous, they therefore form a very fine net-work of canals in the midst of the compact substance. The arteries and veins which occupy them are disposed to keep apart, each set of vessels having its own canals; at least this is to a considerable extent the case, a very strong example of which is seen in the venous diploic sinuses of the bones of the head, and in the bodies of the vertebræ. The interior of a Haversian canal is lined by a layer of compact substance, and exterior to this layer is the concentric series of other layers in a variable number, from four to twelve or more, according to Henle[2] and others. The concentric condition is, however, not absolute, as the layers run here and there into one another, owing to the arrangement of the corpuscles of Purkinje. From the great number of the longitudinal Haversian canals, a long bone, when tested by a microscope, seems to be formed in its compact texture almost wholly by them, so that it is really a fascis or bundle of the little stems, or ossicles forming the Haversian system, comparable to a bunch made of the barrels of quills.

The cancellated and the cellular structure are themselves a more expanded development of the same arrangement.

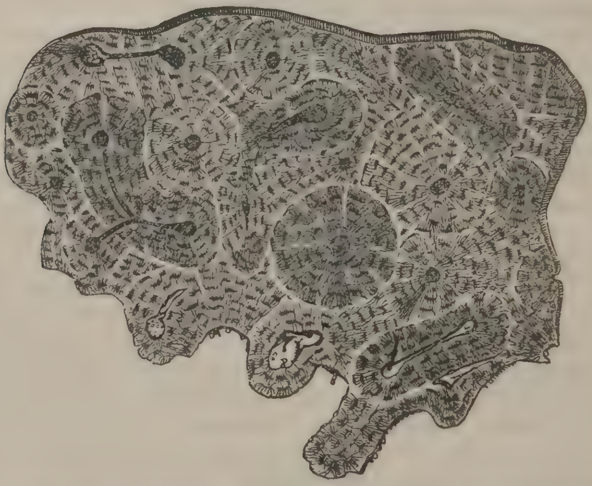
Microscopic excavations of a different description, and called Calcigerous, also exist in bones. They are brought into view by examining a transverse section of bone ground extremely thin and then polished. They consist in cells (Corpuscula Purkinje) from which radiate in every direction exceedingly fine tubules (Tubuli Calcigeri, or Calciphori), which again send out branches, to anastomose with corresponding branches of similar adjoining cells. The term calcigerous was applied to this system from the belief that the calcareous matter of bones is

[1] Osteologia Nova, An. 1729.
[2] Histoire des Tissues, tome ii. p. 397.

deposited in them.[1] Under a microscope which magnifies from two to three hundred diameters, some very fine striæ, like the radii of a circle, are seen in great numbers diverging in straight lines from the circumference of the Haversian canals to the circumference of the little cylinders of bone forming them, protruding through and through their laminæ. They are called the canals of Deutsch, but are considered as identical with the corpuscles of Purkinje and their calcigerous tubes, the appearance of being distinct from them proving delusive.

The Corpuscles of Purkinje and their stellate branches are now viewed by anatomists as a very beautiful arrangement of small lenticular or flattened oval excavations, in great numbers, with their radiating tubules anastomosing with those of adjacent similar excavations. A

Fig. 13.



Section of a human femur, about its middle, exhibiting the ends of the Haversian canals, and their relation to each other, also how each one is surrounded by its series of concentric lamellæ making the ossicle of Havers. This laminated condition is well shown by polarized light, which causes the corpuscles to disappear, and the laminæ to be well defined.

granular matter is found within them and their branches. The tubules take their origin from the interior of the Haversian canals, according to Mr. Tomes,[2] and pass in series between the canals, connecting them one with another. They then reach the surface of the bone, and end on it by open orifices, or are reflected back into the tissue of the bone, to enter the tubules adjoining.

The proof of this system being permeable is that, if a dry section of bone in which they are very visible, be touched with a drop of oil of

[1] The corpuscles of Purkinje, called after their discoverer, are among the most permanent of the anatomical traits of bone, notwithstanding their extreme minuteness. In the petrified vertebra of a Zeuglodon (whose remains abound in the limestone of Alabama) sent to me by Dr. Alonzo B. C. Dossey, the corpuscles were exhibited in great abundance and very distinctly with the microscope, by Dr. Joseph Leidy. This race of animals, having a length of about seventy feet, has been named by Professor Owen from the transverse section of the teeth being in some degree a resemblance to the outline of an hour-glass; and is considered as cetaceous by him instead of saurian, as originally suggested by Dr. Harlan. Being found uniformly in the fossilized state, its antiquity defies human computation.

[2] See Physiolog. Anat. Todd and Bowman, p. 109.

turpentine, this fluid will penetrate quickly into the Haversian canals, from thence into the stellate tubules, thence into the lenticular excavations; thence through the tubules on the other side, and so on from one set to another till all be filled. When air has pre-occupied these spaces, and the turpentine can not displace it, the bubbles are very apparent.

These lacunæ, or corpuscles of Purkinje, have their flat sides for the most part in line with the nearest surface of bone. They have an average length of $\frac{1}{1800}$th of an inch, are about half as wide, and one-third as thick. The radiating tubules are from $\frac{1}{20000}$th to $\frac{1}{12000}$th of an inch in diameter. Each class of animals has, according to Mr. Queckett, its characteristic lacunæ.

The preceding exposition of the texture of bones may be summed up in the example of a long bone, which is, in itself, a good specimen of the arrangement everywhere else to be met with, under some modifications. Upon the exterior periphery of the bone we see the surface occupied with an immense number of foramina for the transmission of vessels: upon the interior formed by the medullary canal, and the areolar structure, we have also great numbers of orifices showing the vascular connection of the medullary membrane, and, finally, in the intermediate compact structure, we have the bone made cribriform by the numerous microscopic channels of the Haversian canals; and the lacunæ and tubules of the Purkinjean system. It is estimated that these developments of surface bring every point of bone within a small distance, $\frac{1}{170}$th of an inch, from a blood-vessel.

Bones exhibit a superficial layer obtained directly from the external periosteum. A similar layer is derived from the medullary membrane, and forms the areolar structure. These two layers send out the compact osseous lining of the Haversian canals. As the lacunæ or corpuscles of Purkinje are everywhere in the bone, their planes change their directions, so as to observe that of the adjoining Haversian canals and ossicles, whether they be longitudinal, transverse, or oblique.

The radiating canals of Deutsch, which are like fine lines or filaments drawn from the Haversian canal of an ossicle to the outer circumference of the latter, are formed by a linear series of lacunæ, the longer diameters of which face inwards and outwards, and inosculate with those in the same line centrally and peripherally. Each lamina of the ossicle is thus rendered porous; and the ossicle may, as observed, be described as a bone of itself, having for its centre a Haversian canal, containing a blood-vessel. As the corpuscles of Purkinje, and the radiating tubes of Deutsch communicate reciprocally by being in fact the same system, and connect also with the canal of Havers, so every bone is formed largely of these systems of anastomosing tubes; the larger of which to wit, the Haversian only, conduct blood-vessels, while the other, being too fine for that purpose, transmit merely the nourishing juices of the bone (the sap, we may say), derived from the blood. This arrangement of bone into canals compensates for its want of bibulous properties like cartilage, and the softer substances of the human body; and thereby secures to it an adequate degree of nourishment.

As every round bone is thus formed from a fascis of Haversian cylinders or ossicles, so the latter are held in groups by a cylinder of bone exterior to them all, and by another cylinder which is within, it being

contiguous to the medullary cavity of the bone. The spaces existing between the contiguous Haversian ossicles are filled up by concentric lamellæ of bone, running in line with those of the external and internal cylinders.

From the researches of Mr. Tomes,[1] it appears that the ultimate structure of bone is granular. This arrangement is manifested both by calcination and by steeping in an acid. These granules are intermixed with the osseous lacunæ called the corpuscles of Purkinje.

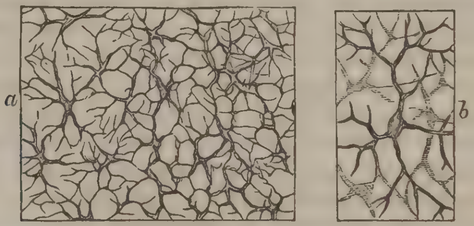
If a thin natural plate of bone, as, for example, a fragment of ethmoid, be examined microscopically, it is found not penetrated by blood-vessels, but is nourished simply from its surface by the vascular periosteum there. Tested by prolonged boiling, so as to remove largely the animal matter, it is seen to consist of granules of osseous or calcareous matter, varying in size from the $\frac{1}{14000}$th to the $\frac{1}{6000}$th of an inch. A piece of this description exhibits the osseous tissue in its simplest state, and is dotted

Fig. 14.

Purkinjean Corpuscles magnified 500 diameters.—*a*. Central cavity. *b*. Its ramifications.

abundantly with the Purkinjean corpuscles sending out their stellated arms, which anastomose freely with others. The minute granular matter filling the corpuscles is thought to have the faculty of drawing the nutritive materials of the adjoining blood-vessels, by the intervention of a set of minute cells contiguous to the osseous tissue. A scale of some fish, as the Lepidosteus,[2] which has no blood-vessels in it, exhibits a strong analogy with this arrangement in the human bone, there being an intertexture of canals like a net-work. The plates forming the cancellated structure of the thicker bones repeat the same exhibition, the nutritive matter being attracted into their substance from the vascular membrane covering them.

Fig. 15.



Section of a bony scale of the Lepidosteus.—*a*. Showing the regular distribution of the lacunæ and of the connecting canaliculi. *b*. Small portion more highly magnified.

[1] Physiol. Anat. &c., by Todd and Bowman, p. 108, London, 1843.
[2] Carpenter, Elements of Physiology, &c., Phila. 1846.

A simple experiment on any of the cylindrical bones will prove that the tumefaction of their extremities does not add proportionately to their weight, as one inch or any other given section of the compact part weighs very nearly the same with a section of equal length from the cellular extremities. This swelling at the ends of the bones adds much to the safety of their articular union, as the extent of the surfaces is thereby much increased, and, consequently, they are less liable to displacement. The cylindrical and the cellular cavities, thus formed in the long bones, by increasing the volume of the latter, add greatly to their strength beyond what would have occurred, had the same weight of material been solid. The late Dr. P. S. Physick instituted a demonstration of this most satisfactorily by a scroll of paper, which, on being rolled up successively into cylinders of various sizes, has, like a lever, its power of sustaining lateral pressure on one of its extremities, continually increased as its volume or diameter is augmented, until the latter reaches a certain extent. The same highly distinguished teacher also pointed out another very important advantage of the cellular structure. It is that of serving to diminish, and in many cases to prevent concussion of the brain, and of the other viscera, in falls and in blows. The opinion was verified by his demonstrating the momentum, which is communicated through a series of five ivory balls suspended by threads, when one of them is withdrawn from the others, and allowed to impel them by its fall. This momentum is so completely transmitted through the series, that the ball at the farthest end is impelled almost to the distance from which the first one fell. This familiar experiment, used as a preliminary test to the accuracy of his views, was immediately succeeded by his substituting for the middle one of ivory, a ball made of the cellular structure of bone. The same degree of impulsion now communicated at one end of the series, is almost lost, or rather neutralized, in the meanderings of the cellular structure of the substitute; and particularly if the latter be previously filled with tallow or well soaked in water, so as to bring it to a condition of elasticity resembling the living state.

In persons of advanced age, the marrow of the bones becomes more abundant, and their parietes thinner; we also observe then, that the bones break more readily, and are more crumbling, rotten, or soft, than during the anterior periods of life. In women, after the critical period is passed, these traits are especially developed, and the compact centres of the long bones have their texture more or less approximated to the spongy tissue. Mr. Velpeau[1] says, that in the amphitheatres of Paris, he has often cut easily with a scalpel the ends of the femur, tibia, humerus, the bodies of the vertebræ and the tarsal bones, when there was apparently no morbid lesion in the skeleton: a similar experience belongs to most practical anatomists.

SECTION II.—COMPOSITION OF BONES.

The bones, under every modification of shape and mechanical arrangement, are constituted by precisely the same elementary matters:

[1] Anat. Chirurg.

the principal of which are an animal substance, cartilage; and earthy matter, in intimate combination. Their minute analysis, according to Berzelius, when they are deprived of water and of marrow, affords

32 Parts of cartilage or gelatin, completely soluble in water;
1 Of insoluble animal matter;
51 Phosphate or rather subphosphate of lime;
11 Carbonate of lime;
2 Fluate of lime;
1 Phosphate of magnesia;
1 Soda and muriate of soda.

There are some other ingredients manifested in the analysis of Fourcroy and Vauquelin, as iron, manganese, silex, alumen, and phosphate of ammonia. The relative proportions of the above ingredients are not uniformly the same, as the bones of the cranium, and the petrous portion of the temporal in a remarkable degree, have more calcareous matter in them than the other bones of the same skeleton. There is also a considerable diversity in individuals, according to their age and to certain morbid affections. Thus, according to Schreger,[1] the bones of a child have one-half only of earthy matter, while those of an old person have seven-eighths of the entire mass.

The coloring of the skeleton by madder, when an animal is fed on it, is considered a sufficient proof of the phosphorus and calcium being in the state of phosphate of lime.

The *Earthy* matter gives to bones their hardness and want of flexibility, and is easily insulated from the other by combustion; which, in destroying the animal part, leaves the earthy in a white friable state, but preserving the original form of the bone. If the heat be of a high degree, the calcareous part becomes vitrified, and its cells are blended by fusion. The action of the atmosphere, long continued, also divests the bones of their animal matter, and the calcareous then falls into a powder. If the bones be kept beneath the surface of the ground, by which they are less affected by changes in temperature and moisture, the animal matter remains for an immense number of years. There are in the Hunterian Museum of London, preparations of the teeth of the Mastodon or Mammoth, in which the animal matter is exhibited entire, notwithstanding the great lapse of years since it was in a living state: and a repetition here of the same experiments on the teeth and bones of the same animal has exhibited the same result. Animal matter has been detected in fossil shells, the existence of which was probably anterior to that of the human family.

The phosphoric acid of bones gives them a luminous appearance at night. Bichat says, that in these cases he has found an oily exudation on the luminous points, probably from the marrow or contiguous soft parts. This phenomenon will account for many of the superstitions which in all ages have affected ignorant minds on the subject of burying-grounds.

The immersion of a bone in diluted muriatic acid is the best method

[1] Müller's Physiol. p. 393.

of demonstrating the *Animal* substance in a separate state. The strong affinity of the acid for the earthy part, and the soluble nature of the salt thus formed, leave the animal matter insulated. In this state it preserves the original form of the bone, is cartilaginous, flexible, and elastic. The action of hot water alone, upon a bone, by continued boiling, will, from the soluble nature of the cartilage, separate the latter from the earthy part, and convert it into gelatin. The gelatin may be precipitated afterwards from the water, by tannin. The mode of this combination of animal and of earthy matter is not understood, but it is generally supposed to exist by the extremely small cavities of the former receiving earthy particles, in the same way that a sponge holds water.[1]

Müller[2] says, that his investigations have elicited the remarkable fact of the cartilage of bone before ossification, consisting of chondrin, but afterwards of ordinary gelatin: and that bones affected with softening no longer yield gelatin, but contain a large quantity of fatty matter.

There are no means for investigating the minute texture of the bones more instructive than the removal of the earthy part by an acid. The cartilage thus left is the complete mould, in every particular of form, into which the particles of calcareous matter were deposited. In this state, the compact part of the bodies of the cylindrical bones may be separated into laminæ; and these laminæ, by the aid of a pin or finely-pointed instrument, may be subdivided into filaments or threads. (See Figs. 9, 11.)

When a very thin lamella of softened bone is peeled off from the surface, it presents distinctly a fibrous condition, in a reticulated state, and adhering at the points of intersection. It is considered by Prof. Sharpey as being unequivocal white fibrous tissue. There is certainly much less difference between the fibre of bone cartilage and the white fibre than one would suppose from ordinary examination. For, if the upper end of the os femoris be softened in an acid, with its capsular ligament left, it will be found very difficult, owing to the uninterrupted continuity of the two, to detect where the ligamentous fibre ends and the cartilaginous fibre begins.

The laminæ of round bones, though enclosing one another, are not exactly concentric. I have observed, that the more superficial come off with great uniformity and ease in the adult bone, but the intertexture continually increases towards the centre. Bichat has objected to this dissection of the bones, that the laminæ are not formed in nature, but factitiously,

[1] If we conceive the phosphate of lime and the other earthy materials of bone to be in a state of solution in the blood and serum with which the cartilaginous rudiment of the bone is impregnated, any action which would precipitate the earthy materials would also, of course, impregnate the cartilage with them, and this process may be considered as completed when the bone acquires its proper consistence.

Considering cellular substance as the parenchyma or primordium of all other parts, it is probably a speculation not entirely groundless, that every peculiar tissue or glandular texture has its elements precipitated from the circulating fluid in a manner analogous to that of the calcareous part of bone. This idea also affords a clue to a result almost uniform in protracted macerations of all tissues, to wit, the parts being brought back to the primordial state by the peculiar deposits in them being dissolved in the water and removed.

[2] Physiol. p. 393.

by the art of the anatomist, and that their thickness depends entirely on the point at which one chooses to separate them; they, therefore, may be made thick or thin at pleasure. It does not appear to me difficult to account for the manner in which this laminated arrangement is produced. The longitudinal filaments of the bones adhere with more strength to each other at their sides than they do to those above or below, in consequence of which a plane of these filaments may be raised at any place and of any thickness. This fact does not involve the inference that the bones are originally formed by a successive deposit of one lamina over another; it merely inculcates the mode of union between the filaments or threads. But that the periosteum secretes the external laminæ in the adult bone, as previously alluded to, is true, inasmuch as they separate with unusual or peculiar facility from the subjacent one. We know that the periosteum has the power of this secretion, as a laminated deposit of bone on the roots of the adult teeth frequently met with proves, without doubt; as also the phenomena of necrosis. The vascular net-work of the periosteum is analogous or correspondent to that of the bone, for which reason it is that this membrane is one of the tributaries to the supply of bone in its growing stage, but not in virtue merely of its fibrous character. The history of the abnormal formation of bone in any one or all of the tissues of the body, is also a proof that whenever there are vessels it may in certain cases be secreted.

The disposition of the cylindrical bones to separate into laminæ is constantly manifested in such as are simply exposed to the atmosphere.

The opinion of the laminated and filamentous arrangement of bones has been very generally received by anatomists. Malpighi, whose name is inseparably connected with minute investigations in anatomy, taught it. Gagliardi, also, in admitting it, thought he saw pins of different forms for holding the laminæ together. Havers also saw the laminated and thread-like structure. In short, there are few of the older anatomists who have not adopted fully the opinion. Among the moderns, the late M. Béclard, the distinguished and able Professor of Anatomy in the School of Medicine in Paris, says, that when the earth is removed from bones by an acid, if they be softened by maceration in water, the compact substance, which previously offered no apparent texture, is separated into laminæ, united by filaments; the laminæ themselves, at a later period, separate themselves into filaments, which, by a further continuation of the process, swell, and become areolar and soft. A long bone examined after this process divides its body into several laminæ, the most external of which envelops the rest; and the remainder, by rarefying themselves towards the extremities, are continuous with the cellular structure there.

J. F. Meckel, of the University of Halle, has furnished the following account in his General Anatomy of the Bones:—

"The filaments and the laminæ which constitute the bones are not simply applied one against the other, so as to extend the whole length, breadth, or thickness of a bone, or to go from its centre to the circumference. They lean in so many different ways, one against another, and unite so frequently by transverse and oblique appendages or pro-

cesses, that some great anatomists, deceived by this arrangement, have doubted the fibrous structure of bones. Nevertheless, their opinion is not perfectly correct. In spite of those inflections and anastomoses of fibres, the fibrous structure always remains very apparent, and one is warranted in saying that the dimension of length exceeds the two others, in the texture of many bones. This predominance is chiefly well marked in the first periods of osteogeny, for, at a later time, the fibres are so applied against each other, as scarcely to be distinguished. But these longitudinal fibres never exist alone; there are many oblique or transverse ones from the first periods of ossification; and they are even from the beginning so multiplied, that the number of longitudinal fibres does not prevail over them so much as at a subsequent period, when the fibres approach nearer, in such way that the transverse become oblique; until at last, from the increase of the bone, the latter at first view seems to be composed only of longitudinal fibres. The transverse and oblique fibres do not form a separate system, but continue uninterruptedly with the longitudinal, which they unite to each other."[1]

The venerable Scarpa, some years ago, advanced opinions adverse to the laminated and fibrous or filamentous tissue of bones.[2] The latter doctrine he was induced to think a mere mistake, arising from careless observation. Founding his own views upon what he had seen in the growing bone, in the adult bone when its earthy parts were removed by an acid, and upon certain cases of disease attended with inflammation of the bone, he denied, without reservation, the existence of laminæ and fibres in bones, declaring that even the hardest of them were cellular or reticulated. It appears to me, in looking over his paper, that a desire to overthrow old doctrines and to establish new ones has induced him to make one omission in the report of his experiments, otherwise unaccountable in a man of his general intelligence and candor. Having softened the cylindrical bones in an acid, he next proceeds to a long-continued maceration of them; he finds, as other persons have done, the animal part of the bone finally resolving itself into a soft cottony tissue. He has made but one step from the immersion in the acid to the last stage of the process of maceration. Now if, in a short time after the bone had been softened in the acid, he had admitted an intermediate observation, he would no doubt, like all other inquirers, have found that the animal part of the cylindrical bones was readily separable into laminæ; and that, by a pin or needle, these laminæ could be split into fibres, the greater part of which are longitudinal; and that pounding the ends of these fibres with a hammer would resolve them into a very fine penicillate or brush-like structure. There is no objection to the conclusion that these laminæ and filaments, as a final condition, produce a very fine microscopical cellular arrangement, which may be made more apparent in being distended by the development of gaseous substances, arising from putrefaction or mace-

[1] Manuel D'Anat. Gen. Descr. et Path., traduit de l'Allemand par Jourdan et Breschet. Paris, 1825.

[2] A. Scarpa. De penitiori ossium structura commentarius. Leips. 1795. See also Anatomical Investigations, Philadelphia, 1824, by the late J. D. Godman, M. D., for an English translation of the same.

ration; but there is reason for a decided opposition to the assertion of there being no fibres in bones when we have daily under our eyes preparations showing them; some of which demonstrate the fibres running principally longitudinally, others spirally, like the grain of a twisted tree, and others having a mixed course. Upon the whole, the description cited from Meckel exhibits this subject in a just and accurate manner.

The more obvious arrangement of the cellular and compact structures of the bones indicates a considerable difference in their intimate texture: they are, nevertheless, closely allied, for one structure is converted, alternately, into another by disease—of which specimens abound in the Wistar Museum. In both cases, from the fibres or filaments are formed cells which exist everywhere, and are only larger and more distinct in what we call the cellular structure; but the compact part has also its cells, as seen from the preceding account, though they are smaller, more flattened, and for the most part microscopical.[1]

Organization of Bones.

The blood-vessels of the bones, though small, are very numerous. This is well established by the success of fine injections, which, in the young bone, communicate a general tinge, and by scraping the periosteum from living bones, whereby their surface in a little time becomes covered with blood, effused from the ruptured vessels. In those operations for exfoliation from the internal surfaces of the cylindrical bones, where it is necessary to excavate the bone extensively in order to remove all the detached pieces, unless the general circulation of the limb be previously arrested by the tourniquet, the cavity of the bone is flooded with blood. Bichat has also remarked that the blood-vessels of the bones become unusually turgid and congested in cases of drowning and strangulation. The observations in 1832, on cholera in Paris, showed the same congestion of black blood to have been produced by that disease.

The arteries which supply the bones, from their mode of distribution, are referred to three classes. The most numerous and the smallest,

[1] The intimate structure of the bones has been most carefully explored in modern times, and our knowledge of it is very largely due to observations within a few years, as seen. At a former period, Havers had discovered the small canals known now by his name, and also called medullary. Leeuwenhœck had described the calcigerous canals and the osseous corpuscles.* Gagliardi† gave a good description of the lamellæ and filamentous arrangement of the bones. His observations were confirmed, and further illustrated, by those of Duhamel‡ and some others. Malpighi considered the bones as formed by a uniform network of fibres§ within the interstices of which the calcareous elements were deposited, and he rejected the idea of a lamellated arrangement, except so far as it was artificially produced by the manipulations of the anatomist.

In regard to subsequent opinions on this point, Scarpa, as just stated,‖ rejected the sentiment of the lamellated and fibrous condition of bones, and asserted that the bones consisted in a reticular cellular tissue, which in the flat and thick bones is perfectly homogeneous, the only difference between the spongy and compact tissue being, that the latter is more dense in its structure than the other.

* Anat. S. Inter. Rer. p. 261, 1687.
† Anat. Oss. p. 11, an. 1689.
‡ Acad. de Paris, from 1739 to 1743.
§ Oper. posthuma, p. 47, an. 1697.
‖ De Penit. Oss. Struct. 1799.

are those which penetrate from the periosteum, by the capillary pores found over the whole surface of the bones. The next are those which penetrate the larger foramina at the extremities of the long bones, and at different points of the surface of others, and the third class, called nourishing, amounts to but one artery for each of the cylindrical bones which penetrates by an appropriate canal, as mentioned, commonly near the centre of the bone.

The arteries of the first two classes are generally extremely small. They ramify upon the compact and cellular structure, penetrating it in every direction. At death, they are commonly filled with blood, which renders the injection of them difficult. The third, or as commonly called the nutritious artery, is of a magnitude proportioned to the bone to be supplied. Being single in almost every instance, it passes through the compact tissue, and having reached the medullary cavity, it divides immediately into two branches; each of which, in diverging from its fellow, goes towards its respective extremity of the bone. These branches ramify into countless capillary vessels upon the membrane containing the marrow,[1] and finally terminate by free anastomoses with the extreme branches of the other two systems.

The veins of the bones are very abundant. Some are in company with the branches of the third, or nutritious arteries, and their common trunk goes out at the nutritious foramen, into general circulation. These ramifications have been long known, and bring back the blood from the medullary membrane only. But the veins which receive the blood of the other arteries do not attend them, and were first of all found in the diploic structure of the cranium, which led to the discovery of them in all the other bones. The honor of the original observation was claimed respectively by two very distinguished men of Paris, MM. Dupuytren[2] and Chaussier.[3] These veins issue from the bones by numerous openings distinct from those furnishing a passage to the arteries. This circumstance is remarkably well seen in the flat and thick bones, and at the extremities of the cylindrical ones. Having left the bone, they terminate, after a short course, in the common venous system. They arise exclusively from the spongy and compact structure, by extremely fine arborescent branches, which, uniting successively, form trunks; these trunks penetrate the compact tissue, and escape from the bone by orifices which are uniformly smaller than the bony canals of which they are the terminations. The canals are formed of compact substance, continued from the external surface of the bone, and are lined by the contained veins. They are, in fact, the same with the Haversian canals. The parietes of the canals are penetrated by smaller veins entering into the larger. M. Dupuytren is of opinion that only the internal membrane of the venous system exists in this set of veins; that it adheres closely to the bone, so as to be incapable of exerting any action upon the blood; that it is very thin, weak, transparent, and is thrown into numerous valves. The several sets of arteries and of veins respectively anastomose with one another.

[1] Would not this furnish a hint that the arteries from which fat proceeds are different from other arteries, and that this distinction may prevail generally?

[2] Propositions sur quelques points d'Anatomie, Physiologie, &c., Paris, 1803.

[3] Exposition de la Structure de l'Encéphale, Paris, 1807.

Lymphatic vessels are generally seen only on the surface of the bones. Mr. Cruikshank, however, on one occasion, while injecting the intercostal lymphatics, passed his mercury into the absorbents of a vertebra, and afterwards saw them ramifying through its substance;[1] a fact which, along with what is known of the power of exfoliation in bones, proves sufficiently the existence of such vessels in them. A few other anatomists, as Sœmmering, Breschet, and Bonamy, lay claim to similar observations. The testimony of the former may be considered as going far to confirm the fact, as he has all along been admitted as one of the most accurate and cautious observers of modern times. The opinion is, however, rejected by others of almost equal celebrity.

Nerves have also been traced into the bones, accompanying for some distance the nutritious arteries on the medullary membrane; but there is no proof yet of nerves being distributed to the osseous substance itself.[2]

CHAPTER II.

SECT. I.—OF THE PERIOSTEUM.

THE membrane which surrounds the bones externally is called periosteum (*Periosteum Externum*), and is extended over their whole surface, excepting that covered by the articular cartilages. As this membrane approaches the extremities of the bones, it is blended with the ligaments uniting them to each other, from which the ancients adopted the opinion, that the ligaments and periosteum were the same. Many fibres pass to the bone from the periosteum, by which it is caused to adhere. These fibres are more numerous and strong at the extremities than in the middle of the cylindrical bones; also upon the thick bones, than upon the flat ones. The blood-vessels of the bones accompany these fibres and contribute to the adhesion. The periosteum is united to the muscles and to the parts lying upon it, by cellular substance.

The organization of the periosteum is fibrous; the fibres pass very much in the same direction with the fibres of the bones, excepting the flat bones, on which they are not radiated. These fibres have different lengths; the more superficial are longer, while the more deeply seated extend but a small distance. Inflammation develops the fibres in a striking manner, by occasionally making the membrane as thick as an aponeurotic expansion.

The blood-vessels of the periosteum are numerous, and can be easily injected. They come from the contiguous trunks, and ramify minutely, into a vascular net-work, many of whose branches penetrate into the bone, and have the distribution already mentioned. A few lymphatic vessels have been observed in it. Its nerves have not been clearly dis-

[1] Anatomy of Absorbing Vessels, p. 98, London, 1790.
[2] Béclard, Elemens d'Anatomie Générale, Paris, 1823.

Fig. 16.

The External Periosteum laid open and turned off from a young humerus.

covered, though the sensation of extreme pain, when violence is done to it in an inflamed state, may be thought a proof of their existence. In health its sensations are null, or extremely obscure.[1]

The adhesion of the periosteum to the bones varies in the several periods of life. In infancy it may be separated from them with great facility; in the adult it adheres more strongly in consequence of its internal face having taken on a secretion of bone, by which it is blended intimately with the bone it surrounds; and in old age it is still more adherent, from the progress of its ossification. It is thick and soft in the infant, and becomes thinner and more compact as life advances.

The periosteum receives the insertion of tendons, of ligaments, and of the aponeuroses. For some years after birth, owing to their slight attachment to the bones, all these parts may be torn from them, with but comparatively little force. Bichat,[2] having advocated the opinion that the internal laminæ of the periosteum became ossified in the adult, considered this as a means by which all the afore-mentioned insertions into it were identified with the bones, and thus accounted for the great degree of tenacity with which they adhere, and the immense force they are capable of sustaining, without being detached from their insertions. In this tendency to ossify, the periosteum manifests a great similitude to other fibrous membranes, as the dura mater, the sclerotica, and the tendons.

The real state of the case is that the periosteum does not insinuate itself as a distinct layer between such insertions and the bone. It ought rather to be said that the fibrous character which is common to the periosteum, the animal part of bone, and the tendons, ligaments, and aponeuroses, is so uniform that, if a bone with these others attached is softened in an acid, it will be seen that there are no strict limits observed between them, but that these several textures run into each other, and have their filaments so continuous, that they have no lines of separation whatever, but are rather identified or blended, the one with the other, wherever an insertion or firm attachment is in question.

The use of the periosteum is to conduct the blood-vessels to the bones; to protect the latter from the impression of the muscles, and other organs, which come in contact with them; to keep the ossification of the bones within its proper boundaries; to give shape to them; and to secrete bone in the growing state or in fractures. Finally, as was suggested by the late Dr. Physick, it exerts a very happy influence in turning from the bones suppurations in their vicinity, which would otherwise be pernicious to them.

[1] Purkinje, it is said, has found a copious net-work of nervous filaments in the periosteum.

[2] Anatomie Générale.

SECT. II.—OF THE MEDULLA, AND ITS MEMBRANE, CALLED THE INTERNAL PERIOSTEUM, OR ENDOSTEUM.

The Marrow (Medulla) is contained in a very fine vascular membrane (*Periosteum Internum*), lining the internal cavities of the bones, and, sending into their compact substance very delicate filaments. The existence of this membrane has been denied, but it may be established by sawing a bone in two, and approaching the cut end to the fire, so as to melt out the marrow; also, by digesting a bone for some days in hot spirits of turpentine, or by immersing it in an acid, in which cases the membrane becomes crisp and distinct. Its delicacy is so extreme that it can only be compared to an amorphous film. In this state it may be traced, lining the whole cylindrical cavity of the long bones, and extending itself to their extremities. It also exists in the diploic or cellular structure of all the other bones; but it is scarcely possible to demonstrate it there in a very distinct manner, owing to its extreme tenuity.

The medullary membrane is composed principally of the minute and numerous blood-vessels spent upon the internal surface of the bones, aided by a very fine, soft, areolar tissue, merely sufficient in quantity to fill up the meshes between the frequent anastomoses of the vessels. From the latter cause, it is compared to the pia mater and to the omentum. It has been stated that its blood was derived from the nutritious artery, which communicates freely with the other arteries of the bones. This membrane is so arranged as to form along the course of the blood-vessels small vesicular appendages which contain the marrow, and bear some analogy to a thick bunch of grapes, hanging from the several pedicles of the stem.

Its nerves are extremely small; they enter by the nutritious foramen, and have been particularly observed by Wrisberg and Klint.[1] They have not, as said, been traced ramifying in the substance of the bone, but follow for some distance the course of the principal arteries.

With the exception of Mr. Cruikshank's solitary injection of a vertebra, and the few anatomists making similar declarations alluded to before, p. 90, no lymphatics have been observed satisfactorily on this medullary membrane; and such lymphatic trunks of the external periosteum as are supposed to arise from the medullary membrane have not been traced nearer to it than the orifice of the nutritious canal.

Marrow.—A greasy substance, as already stated, fills the cells of the bones; it does not, in its composition, differ from common fat; its granules, however, seem to be somewhat finer. From its resemblance in position to the pith of vegetables, it has obtained the name of medulla, or marrow.

Some differences exist in the nature of the medullary membrane or endosteum; for example, that part of it which is reflected over the cells in the extremities of the long bones, and in the whole interior of the flat and of the thick ones, contains a much more bloody and watery marrow than what is found in the cylindrical cavities of the long bones; the

[1] Béclard, loc. cit.

latter, indeed, resembles closely, as just stated, common adeps, presenting no essential differences from it. The fat in the humerus of the bullock amounts to 96 per cent. of the medulla, and in very corpulent human subjects, cannot be much less; it deviates much, however, from that proportion, according to the general state of health, until in extremely protracted diseases the adipose matter disappears, as in all other parts of the body. On the contrary, the medulla of the diploë, and cellular structure of all bones, makes a reddish, gelatiniform pulp, which, according to the analysis of Berzelius,[1] has scarcely a trace of fat; it being composed of water 75.5; and solid matters 24.5, identical with those eliminated from meat by water, as albumen, coloring matter, extract of meat, and the ordinary saline substances. These circumstances have given occasion to divide the medullary membrane into two varieties.

That variety contained in the cellular extremities of the long bones, and in the spongy bones generally, is in a superior degree vascular. The part filling the meshes of its vessels is, however, so imperfect, that Bichat declared his inability to find it, and that the number of the fine vessels was what gave, fallaciously, the appearance of a membrane; while, in fact, the intervals between them were large, to allow the fat to come into contact with the naked bone. The probability of this deficiency is confirmed by the difficulty of finding a membrane in the microscopical pores of the compact substance, yet the existence of fat in it is proved by its becoming greasy when insulated and exposed to heat. There may notwithstanding be extremely attenuated fat vesicles here as elsewhere, with the existence of adeps. It is from the great abundance of blood in this variety of the medullary tissue that the proportion of its adeps is small.

The second variety of medullary membrane is displayed in the cells and in the cylindrical cavity of the diaphysis or body of the long bones. Its membranous cells communicate freely with one another, when the membrane is entire; but according to the observations of Bichat, not with such as are in the epiphyses of the bones, and the line of demarkation is abrupt and well defined. This is proved by attempts to inflate the one from the other; the air, in such cases, passes with great difficulty. The texture of this medullary membrane, from its extreme delicacy in a natural state, is rather obscure, but it is occasionally well developed in disease. Its sensibility has not been very apparent in such cases of amputation as I have seen, though it is said by some to be extremely exquisite. In whatever degree the sensibility exists in different subjects, it is always more apparent in the middle than near the extremities of the long bones; which may be accounted for by its nerves constantly entering at the nutritious foramen, and extending from thence towards the extremities.

It will now be understood that a very strong difference exists between the external and the internal periosteum; the first is decidedly of the white fibrous tissue. The internal is a very delicate areolar tissue, almost amorphous everywhere, and characterized in certain bones, especially the long, by the presence of the fat vesicle, which secretes the

[1] Traité de Chimie, t. iii. p. 486.

marrow. This secretion, however, takes place only very obscurely in the flat, the thick, and the articular ends of the long bones.

The medullary membrane, besides its use in secreting the marrow, is highly serviceable to the nutrition of the bones, as proved in the experiments of Trojat, who, by destroying it, produced their death, and an artificial necrosis, which was cured in the usual way by a new secretion of bone from the periosteum. The marrow which it contains in the adult is not perceptible in the fœtus.

CHAPTER III.

ON OSTEOGENY.

SECT. I.—OF THE DEVELOPMENT OF BONES.

At birth, though the skeleton is sufficiently solid to preserve the shape of the individual, yet it is very imperfect in many particulars, which will be pointed out more in detail hereafter. At present it may be stated that the ends of all the long bones are mostly cartilaginous; the carpus and tarsus are nearly in the same state; the vertebræ, true and false, have their processes very imperfect, and consist, each in several distinct pieces, united by the remains of the cartilaginous state. Several of the bones of the head are in the latter condition; and the sutures are so imperfect that the flat bones readily ride over each other from the thinness of their edges, and also have the angles rounded, which occasions the vacancies called fontanels.

From the early embryo state to the completion of the skeleton, three stages are observed in the progress of ossification; the first is mucous or pulpy, the second cartilaginous, and the third calcific or osseous.

I. *The Mucous Stage.* It is seen at a very early period after the embryo has been received into the womb, and presents itself under two modifications. In the one, from the general softness of the whole structure of the embryo, and from the apparently homogeneous nature of its constituents, the mucous rudiments of bone do not distinguish themselves from the other parts. This condition, however, is soon changed into one, and that before the expiration of the first month of gestation, in which these rudiments assume a solidity and color which mark them off, both to the eye and to the touch, from the still softer parts surrounding them.

II. *The Cartilaginous Stage.* About the expiration of the first month, the mucous stage is converted into the cartilaginous, and its substance is cartilage cells imbedded in a pellucid matrix; the consistence of the bones then increases continually by the accumulation of these constituents. Bichat makes a remark on this subject which has been confirmed by the experiments of Scarpa, though erroneous deductions have been

made by the latter: that we do not see, during the formation of the cartilages, those longitudinal striæ in the long bones, radiated in the flat, and mixed in the thick bones, which distinguish the osseous state. The cartilaginous state presents another peculiarity worthy of observation: all the bones which in a more advanced stage are to be united by cartilage, as the vertebræ, those of the pelvis, and of the head, make, in their groups, respectively, but one piece; while those which are to be united by ligament, and consequently to be movable, as the femur, the tibia, the clavicle, and so on, are respectively insulated. In the pure cartilaginous state the bones have neither an areolar structure nor medullary cavities, and consist in a solid mass; the form of which is sufficiently definite, and has its surface covered by periosteum.

The flat bones of the cranium seem to be an exception to the general rule of a preliminary cartilaginous state, and are commonly thought to be such. Bichat says that the appearance is delusive, from the cartilage being extremely soft and thin, and concealed by the pericranium on the one side, and the dura mater on the other; but that a careful dissection enables one to distinguish it from this double envelop.[1]

The idea of a membranous or rather intra-membranous ossification simply, has been further corroborated by Professor Sharpey, in the case of the tabular bones or flat ones of the cranium. In them it is ascertained that an intermediate membranous layer is between the dura mater and the pericranium. This layer is made up seemingly of filaments of cellular and of fibrous tissue blended with granular corpuscles, and united by a soft amorphous or a faintly granular tissue. The corpuscles are true cells, having an envelop and granular contents; they are the size of blood corpuscles, but some of them two or three times larger. The filaments of the intermediate membranous layer are in insulated bundles and also form a reticulated connection with one another. They receive the ossific deposit, which is consequently in its early stages evidently reticular, and only becomes completely laminar by the finish of the bone itself. It is certainly not repugnant to common observation that parts of the skeleton may have a simply membranous matrix, as instances are so numerous of bone being formed in membranes elsewhere.[2]

III. *The Calcific Stage.*—The calcareous matter begins to be deposited when the rudiments of the bone have become decidedly cartilaginous, with the exception of a few mucous points. In certain bones this change is observable about the commencement of the second month[3] after conception: J. F. Meckel has placed it about the eighth week. The color of the cartilage first becomes deeper, and, in the region where ossification is to commence, is of a well-marked yellow. The blood-vessels, which before this carried only the transparent part of the blood, now dilate, so as to admit the red particles, and a red point is perceived, called the *Punctum ossificationis*, from its receiving the first calcareous deposit. This deposit is always near the very centre

[1] Loc. cit.

[2] For further discussion on the formation of bone, see Human Anatomy by Professors Quain & Sharpey, edited by Joseph Leidy, M. D., pp. 83 to 94, vol. 1st, Phila. 1849.

[3] Béclard, loc. cit. Bichat, loc. cit.

of the cartilaginous rudiment, and not at its surface; the portion of cartilage nearest to it is of a red color; but, a little farther off, opaque and hollowed into canals. The ossification increases on the surface of the cartilage, and in its interstices, by continual deposits, which are always preceded by that condition just mentioned. The canals of the cartilage transmit the blood-vessels, and are large at the beginning of ossification; but, as the process advances and is completed, they diminish gradually, and finally disappear.

The cartilage of ossification, like the permanent cartilages, as the costal, the laryngeal, and some others, is composed of a semi-transparent and somewhat fibrous or filamentous material. Immersed in this are numerous microscopic corpuscles or cartilage cells, flattened slightly and containing a nucleus or several granules.

The definite process of ossification begins by the deposition of calcareous matter in a reticulated manner in the spaces of the semi-transparent matter between these corpuscles. According to Dr. Sharpey,[1] these corpuscles had no definite linear arrangement previously; but upon the approach of the bony deposit they assume one, with their long diameter transverse, and collect into longitudinal rows or oblong groups, the intervals of which are filled by the transparent matrix: and the ends look towards the ossifying surface. The bony deposit finally surrounds completely the cartilaginous corpuscles individually, and the latter themselves are transformed into bone,[2] as proved by muriatic acid, which removing the bone restores the appearance of the original cartilaginous corpuscles.

It is asserted[3] that, after the ossification of the spaces between the corpuscles or cartilage cells, the latter attach themselves to the ossification or cancellated structure as it exists, and in being ossified themselves their nuclei escape the process, and finally become the lacunæ or corpuscles of Purkinje, and that a new substance or blastema is formed in the cancelli, from which probably the vessels of the bone are developed for its future growth. The Purkinjean corpuscle is considered by Schwann, Hassell, and Leidy to be derived from the pre-existing cartilage cell, and its radiating canaliculi to be elongations of the wall of the cell. In the progress of ossification, as an ossific net-work is formed by the deposit of the osseous salts around the cartilage cells, Dr. Leidy[4] considers these elongations to be made at the same period with the ossific deposits and not before, and that the nucleus of the Purkinjean corpuscle disappears a short time after the completion of the corpuscle. The cancelli when first formed are closed cavities, but by farther development become Haversian canals and what they are in the perfect state.[5]

An extension of the preceding processes, with a corresponding development or generation of new cartilaginous corpuscles, finishes finally the complete fabric of the skeleton.

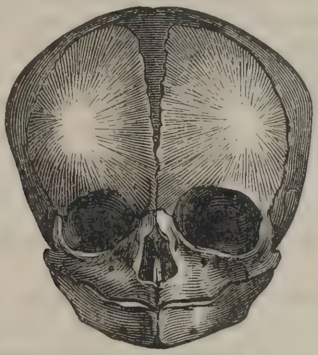
The progress of calcification is somewhat modified in the three classes of bones.

[1] Loc. cit. p. 87. [2] Miescher de Infl. Oss. 1836. [3] Todd and Bowman, p. 120.
[4] Proceedings of Acad. Nat. Sc. Philad. for Dec. 1848, p. 117.
[5] This process has been explained by Mr. Tomes, see Todd and Bowman, ut supra; and also by Quain and Sharpey, Human Anat. p. 89, Phila. edit.

In the Long bones a small ring is observed to form early, near their centre, and to be perforated on one side by the nutritious artery. This ring has its parietes thin, but broad, and its cavity is the beginning of the medullary canal. It is made of very delicate fibres which advance towards the extremities of the bone,[1] and at the same time increase in thickness; so that at birth, the body or diaphysis is generally finished. Commonly, at a period subsequent to birth, but differing in the several bones, their cartilaginous epiphyses also begin to ossify, by the development in their centre of points of ossification which present the phenomena already mentioned. The cartilaginous state of the epiphysis gradually disappears by retiring from the articular end of the bone towards its diaphysis; and, just before its complete removal, it appears as a thin lamina, gluing the end or epiphysis of the bone to its body. Several of the apophyses of the long bones are also formed from distinct points of ossification.

The calcification or ossification of the Flat or Broad bones begins by one or more points, according to the bone being of a simple shape as the parietal; of a double shape or symmetrical, as the frontal, where there are two points of ossification; or of a compound shape, as the occipital and temporal, where there are several points. The commencement of ossification in them is also manifested by the appearance of a red vascular spot in the cartilaginous or membranous rudiment, in which the osseous matter is deposited, and from which it progresses in radiated lines. The periphery of this circle of rays presents intervals between the fibres, giving it the appearance of the teeth of a fine comb:

Fig. 17.



A view of the Punctum Ossificationis in the frontal bone of a Fœtus—the radiating lines from the central point are also shown.

these intervals are subsequently filled up by the sections of radii starting from them, and so on successively till the bone is finished. In the infantile head, the several radii grow at a rate nearly equal; so that where the bones are angular, the angles being most distant from the centre of ossification are finished last of all, from which result the fontanels. Where the bones are intended to be kept distinct from each

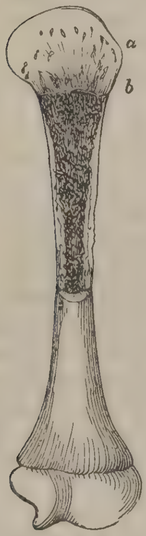
[1] Bichat, loc. cit.

other, their fusion is prevented by a membranous partition; but when they are to coalesce into one piece, only cartilage is found between their edges, and this is subsequently ossified.

In some of the flat bones, as the sternum and the sacrum, there are, first of all, many distinct points of ossification, which quickly unite into a smaller number; they then remain stationary for a number of years, but finally all unite into one piece.

The calcification or ossification of the thick bones begins by one or more points, according to the simplicity or complexity of their figures. The bones of the tarsus and of the carpus have each but one point, while those of the spine have several. The former two, as stated, are almost entirely cartilaginous at birth. The remaining phenomena of ossification in these several bones are the same as has been mentioned.

Fig. 18.



Humerus of a fœtus, natural size. The upper half is divided longitudinally. *a*. Cartilage. *b*. Bone, which terminates towards the cartilage by a slightly convex surface.

The centres of calcification show themselves at different times in the different bones. Gerber[1] considers the process to occur first about the sixth week in our larger domestic animals. The order he lays down is first the vertebræ; then the lower jaw; next the os frontis; next the bones of the face. The middle portions of the ribs are ossified at an early date, and almost cotemporaneously the larger bones of the extremities; the thoracic anticipating the abdominal. We next have the cylindrical bones of the hands and feet, and finally the carpus, the tarsus, and the patella, whose ossification begins somewhat before birth or shortly after. Messrs. Todd and Bowman[2] assert (meaning, as I understand, the human subject), that the ossification of the clavicle is the first, it commencing during the fourth week; the vertebræ and pelvic bones they set down as later.

SECT. II.—ON THE MANNER IN WHICH BONES GROW.

After the cartilaginous condition of the bones has been supplied by the deposit of osseous matter, and they are finished, with the exception of the epiphyses being fused into their respective bodies, the bones still continue to grow till the individual has reached a full stature. This is effected by the successive addition of new matter to the old. The long bones lengthen at their extremities; this is proved by the following experiment of Mr. John Hunter:[3] Having exposed the tibia of a pig, he bored a hole and inserted a shot into each extremity of the diaphysis; the distance between the two shots was then accurately taken. Some months afterwards, when the animal had increased con-

[1] Gen. Anat. p. 187.

[2] Loc. cit. p. 116.

[3] Experiments and Observations on the Growth of Bones. Transactions of a Society for Improvement, vol. ii. London, 1800.

siderably in size, the same bone was examined, and the shots were found precisely at their original distance from each other, but the extremities of the bone had extended themselves much beyond their first distance from the shot. The flat bones increase in diameter by a deposit at their margins, a circumstance which had been known a long time, but it required the ingenuity of Mr. Hunter to prove conclusively that the long bones increase in length by a similar process, and not by interstitial deposit, as Duhamel thought. This observation explains most satisfactorily the use of the cartilage between the diaphysis and the epiphysis in all bones, viz., that it is preserved for forming new cartilage corpuscles and for the purpose of offering the least possible resistance to the new osseous fibres, which grow from the epiphyses and from the diaphyses: that it is kept for this end, from fœtal life and without any material change in thickness, from the fourth or fifth year to the sixteenth or eighteenth, and even later, when it disappears, because there is no longer any use for it, in consequence of the bones having attained their full length.

The epiphyses are then manifestly intended to favor the elongation of the bodies and the development of the extremities of the long bones; to effect the same purposes in some of the flat bones, as those of the pelvis, and to permit the general development of the bodies of the vertebræ. The calcification of the epiphyses commences in some bones about fifteen days before birth, as in the inferior extremity of the thigh bone; and in others, as the ossa innominata, not till the fifteenth year or thereabouts. Many of the processes from the bones are also epiphyses, as the trochanters of the os femoris, the tuber of the ischium, the acromion scapulæ, the seven processes of a vertebra, &c., and are developed in the same way. The time at which they all are thoroughly fused into the bones to which they belong extends from the fifteenth to the twenty-fifth year; depending upon the individual bone, and upon varieties of constitution in different persons: though this process may be considered as completed, generally, in the female at the age of eighteen, and in the male at twenty-one.

The increase in thickness of every bone depends upon a continued secretion from the internal surface of the periosteum, at first soft and mucous, then osseous: when this secretion is arrested, the bones cease to grow in thickness, which commonly occurs some time after they have attained their full length. The changes which subsequently take place in them are those of interstitial deposit and absorption; the deposit is well exemplified in inflammation of the bones, and in spina ventosa; the absorption in the diminution of the bones in extreme old age, and in the loss of the alveolar processes. A species of interstitial growth is also admitted to occur by the dilatation of the primary cancelli and of the Haversian canals. By the observation of Mr. Tomes each of the latter is found, in the experiments with madder, to have its walls deeply tinged with this substance.[1]

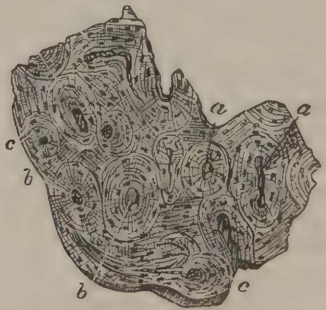
There is great diversity of opinion in regard to the secretion of bone from the periosteum, in the growing stage. Mr. Müller is so decided

[1] Phys. Anat., by Todd and Bowman, p. 123, an. 1843.

on this subject, that he says,[1] the idea that bones are formed by the periosteum appears to him a barbarism unworthy of the present state of physiology. This he grounds upon the principle, that one organ in a part cannot be the nutrient organ of another; therefore, the osseous substance being organized must exclusively assimilate to itself organized matter. This opinion, however decided, is strongly opposed by preparations in the Museum of St. Bartholomew's Hospital; where in cases of necrosis, the shaft of the bone having died, there were plates of osseous substance on the inner surface of the periosteum. In experiments also by Mr. Stanley, a portion of the length of the bone being removed, the periosteum being left, the bone was reproduced; but this latter failed in a case where the periosteum was removed along with the portion of bone. Mr. Syme also obtained a secretion of bone from the under surface of the periosteum, where the latter had been kept raised and separated from the bone, by the introduction of a thin plate of metal.[2] Also in an ossification (*osteophyte*) appended to the internal face of the dura mater, at the base of the falx cerebri, and belonging to the collection of the University of Pennsylvania, the production was found by Dr. Leidy, under the inspection of the microscope, to have the corpuscles of Purkinje and other characters of true bone.

The following figure, drawn from it by Dr. Leidy, is a true exhibit of its structure.

Fig. 19.



a. Haversian ossicles. *b.* Haversian canals. *c.* Corpuscles of Purkinje.

Professor Sharpey's observations go to confirm absolutely this fact, for he declares that the exterior layers of bone are not formed in a cartilaginous matrix, but in the substance of a membrane, consisting of fibres and of granular cells, and exactly resembling that in which the flat bones of the cranium are developed. This membrane, according to him, is the inner layer of the periosteum, which undergoes progressive calcification on the side in contact with the bone, while it is reproduced on the outer side.

The anatomists of Vienna have also ascertained that in the pregnant female, a thin plate of bone is deposited upon the internal and the external face of the bones of the cranium and face, which in some cases that I saw there, was so free from the bone, that it could scarcely have any other origin than the periosteum.

[1] Physiol. p. 408.

[2] Müller, ut supra, p. 471, note by Dr. Baly.

There is no period of life in which the interstitial absorption and deposit is not continually occurring, but it is much more rapid in young and growing animals than in the adult and old. The experiments of Mr. Hunter and of Duhamel show that, when a growing animal is fed upon madder (*rubia tinctorum*), the bones are quickly colored by its being eliminated from the blood, owing to the affinity with phosphate of lime; when the madder is withheld, the bones again become white; and that the first appearance of the restoration of the latter is manifested by a white lamina being deposited on their surface. Successive layers of red and white bone may be thus formed. The madder, under such circumstances, is a long time in getting out of the bones. I fed a young pig for one month on it, mixed with other food. At the expiration of the succeeding five months, the animal, having grown very considerably, was killed. The interior laminæ of all the bones continued to be deeply tinged, while their surface from the deposit of new bone had become white. From this it would appear that deposit is a very permanent condition in bones; it, of course, must prevail much over absorption, else their growth would be arrested.

This effect of madder, first observed by Belchier, and the result of the affinity between madder and phosphate of lime, may be proved as follows, out of the body. No change occurs when an infusion of madder is added to a solution of muriate of lime; but, if a solution of phosphate of soda be added, a decomposition occurs in the two salts, and muriate of soda and phosphate of lime are then formed. The madder is immediately attached to the phosphate of lime, and the latter, being insoluble, falls at once down as a crimson lake-colored precipitate. The coloring matter of the madder, when it is used as food, being introduced into the circulation, its union is thus established with phosphate of lime, and especially with that which is on the eve of being deposited in our tissues.

In very young animals, according to Mr. Tomes,[1] one day is sufficient to tinge the entire skeleton, and in that case, the Haversian canals are each seen to be the centre of a beautiful crimson ring. In old animals the process is much slower, owing to the points of bone being further removed from the blood-vessels, and therefore reached more slowly through the process of imbibition, which, to some extent, must always take place in tissues not wholly vascular.

At the same time that the periphery of each bone is increasing in its dimensions, the medullary canal is also augmenting; this arises from an absorption going on internally, while the deposit is making externally. Duhamel[2] proved this by a curious experiment. He surrounded a cylindrical bone of a young animal with a metallic ring; on killing the animal some time afterwards, he found the ring covered externally by a secretion of bone,[3] owing to the growth of the latter, and the medullary canal as large as the ring itself. Notwithstanding the obvious conclusion from this experiment, he made the mistake of sup-

[1] Todd and Bowman, p. 123.

[2] Mém. de l'Acad. Roy. des Sciences, an. 1739–41–43–46.

[3] If a string be tied around a growing tree, the same thing takes place, and it is finally shut up in the ligneous part.

posing that the bone had enlarged by expansion, and not by a deposit externally, with an absorption internally.

As the individual advances in life, the cylindrical canal, in the centre of the long bones, continues to enlarge in size by the internal absorption, probably by means of the internal periosteum, so that the parietes of the bones, which in early life were much thicker than the canal, and in the adult are also of considerable thickness, become exceedingly thin in old age, resembling thereby a stalk of Indian corn with the pith scooped out.[1] The cells of the cellular structure in the several bones also enlarge, whereby the whole weight of the bones is much decreased in the very aged. In the parietes of the cranium, in extreme old age, there is rather a tendency to the absorption of the diploë, and the approximation of their tables.

The bones, also, become more brittle in old age, in consequence of the increase of calcareous, with a diminution of gelatinous matter. The reverse being the case in infancy, they are more flexible than in the adult, and can even bear to be twisted or bent without breaking.[2]

SECT. III.—ON THE FORMATION OF CALLUS.

As this is a consequence of bones being fractured, and a mode that nature takes to repair the accident, there is some resemblance between it and the primitive formation of bone. Owing to the rupture of the blood-vessels of the bone, of those of the periosteum, and of the medullary membrane, and frequently of the vessels of contiguous parts, the first effect of the accident is an effusion of blood into the cavity of the fracture. The several contiguous soft parts then swell, become hardened and inflamed, and, in the mean time, an absorption of the blood is proceeding; while an effusion of fibrin or coagulating lymph from the ruptured vessels occurs in the cavity of the fracture. This is in fact a nucleated blastema. A ring, the thickest part of which is precisely over the seat of the fracture, is formed by the lacerated parts

[1] There are several examples of this in the Wistar Museum. More rarely the reverse takes place, and the cavity is filled up; of this there are also specimens. We have also an interesting specimen of mollities ossium, or an absorption spontaneously of the calcareous matter, in a married lady, aged 43, the mother of five children, in whom the thigh-bone was broken, without known violence, in two places, as she lay carefully in bed. All the other bones of her skeleton were in the same state of softening, and could be easily cut with a knife. The case has been detailed by the physician who attended her, Dr. J. W. Tenney. See Am. Journ. Med. Sciences, 1840.

[2] The reported instances are now numerous, where, from a defective organization of bone, fracture was produced from very trivial causes; and this state is not confined to any particular age, for it extends from infancy to advanced life. I have attended a fractured os femoris in a child of two years, from a stumble in walking across a carpeted floor. In another child the os femoris was broken, so far as could be learned, by the nurse stooping to reach something from the floor; the same child had both clavicles broken, without any one knowing when or where; the left side was flattened from the fracture, probably a partial one, of several ribs, equally inexplicably. In a third child the tibia was broken from a trifling fall on the floor, and the clavicle from striking the shoulder moderately against the rounded back of a chair.

In these several instances the fragility may arise either from the abnormal relation of the constituents of the bone to each other; by a deficiency of animal matter, which diminishes the tenacity of the bone; or from attenuation, merely, of the bone, leaving its parietes too thin for ordinary accidents.

ossifying: there is also formed in the interior of the bone, as first designated by Dupuytren, a sort of osseous pin. Till this moment the bone itself remains unchanged, with the exception of a coating of the lymph on its broken faces; but now its extremities begin to coalesce or fuse themselves into each other by a fine granular osseous deposit in the blastema, it being the permanent callus; the superfluous bony matter or provisional callus (the ring and the pin), being no longer necessary, is absorbed, and the cavity of the bone with the membranes of the latter is re-established. In this case it will be seen that the deposit of coagulating lymph in the cavity of the fracture corresponds with the mucous rudiments of the fœtal bone, and that the remaining phenomena of ossification are the same. A provisional callus in the human subject is thought by Mr. Paget to be very rare.[1]

Some physiologists have attempted to give to the periosteum the exclusive credit of the formation of callus: the view is erroneous, because experiments show that, even where the periosteum is stripped designedly from the fractured ends of bones, they, nevertheless, unite, and the periosteum is restored when the callus is formed. The probability then is that all the blood-vessels (from whatever source they come) which penetrate the organized coagulating lymph secreted between the fractured extremities, convey and deposit calcareous matter.

The celebrated Bichat and some others were of opinion that, in every case of fracture where the ends of the bones are not kept in contact, granulations spring up from the ruptured surfaces of the bone, and of its membranes; that these granulations first receive into their interstices a soft gelatinous deposit, then a cartilaginous one, and, finally, a calcareous one, by which the bone is united. This process, however, is much more common in compound fractures which suppurate, and may be considered rare in simple ones.[2]

When the calcareous matter begins to take place in a forming callus, if the part be much moved, the process is arrested, the blood-vessels no longer deposit even if they carry calcareous materials, and an artificial joint is formed. The proper period of restoration being once passed, the vessels sink into an inactive state from which they have little or no disposition to rouse themselves. Under these circumstances, the late Dr. Physick proposed, many years ago, the introduction of a seton through the cavity of the fracture, and the retaining of it there for a long time, for the purpose of stimulating the vessels. The plan has now been repeatedly tried, with success, upon the cylindrical bones, and, in one instance, upon the lower jaw.[3]

Callus is formed much more speedily in young persons than in old; occasionally, however, we meet with instances in which the rapidity of its deposit in the latter is remarkable. I, for example, treated, in 1826, a female of ninety, for a simple fracture of the os humeri, which was cured at the end of five weeks.

[1] Carpenter's Physiol. Par. 206.

[2] For a good account of the reproduction of bone, see Müller's Physiology by Baly, p. 455, &c., where there is an analysis of the researches of Miescher, and several other authors.

[3] Dorsey's Elements of Surgery. Philadelphia Med. and Phys. Journ. &c. The os humeri upon which this experiment was first tried, and which shows, very satisfactorily, the state of union, has been deposited in the Anatomical Museum, by Mrs. Randolph, the daughter of Dr. Physick. The hole is still left which the seton occupied.

BOOK I.

PART II.

OF THE BONES, INDIVIDUALLY.

The several textures of the body are so intermixed that the consideration of one alone, pursued through all its applications, excludes for the time, rather artificially, some one or more of the others. This circumstance, inseparable from a clear account, has always perplexed writers on anatomy, and left them under various impressions concerning the best point of departure and method for pursuing their descriptions. Reasons of value may be urged for almost any arrangement: each one will have some peculiar advantages that the others have not, and which will cause it to appear to the understandings of its advocates superior to the rest. For a course of study which is intended to be physiological and surgical in its combinations, the usual practice of beginning with the skeleton is, perhaps, the most advantageous; the young student will, however, understand, that if the skeleton have any natural claim to this precedence, it is principally from its furnishing those landmarks, as it were, to which we refer the situation of other parts, and that it is only conceded, for the purpose of laying a foundation for their more easy and intelligible description subsequently. The human frame may be compared to an extended landscape, the multiplicity of whose features, and the variety of objects spread over whose surface, collectively, bewilder the beholder; but by seizing first on its prominent outlines, marking the course of its mountains and ridges, and determining the bearings of the several objects according to them, we become able, at length, to define not only to ourselves, but to others, the precise position of each point, or each object which may be the subject of inspection.

Unfortunately, the minuteness with which the skeleton is described, has been decried as useless; but the zealous and reasonable student ought to bear in mind, that the only rational plan of reducing a dislocated joint must depend upon a proper knowledge of its articular faces; that many of the great phenomena of life depend essentially upon the arrangement of the skeleton; that locomotion is inseparably connected with it; and that, in short, it has a bearing upon almost every animal operation. With these facts impressed upon him, he will

be prepared to give the description of the skeleton a full and perfect attention.

It is generally agreed to view the following bones as distinct:—

For the Trunk.—Twenty-four true or movable vertebræ, one sacrum, four caudal vertebræ or bones of the coccyx, two innominata, twelve ribs on each side; a sternum, in three pieces, however, in the youthful adult—56.

For the Head—An occipital bone, a frontal, a sphenoidal, an ethmoidal, two parietal, two temporal, each containing the small bones of the tympanum; two superior maxillary, two palate, two malar or zygomatic, two nasal, two unguiform or lachrymal bones, two inferior turbinated, a vomer, and an inferior maxillary—22.

One hyoid, in three pieces, sometimes five in the adult, and situated in the throat.

The remaining bones compose the limbs, and are, therefore, in pairs, or correspond exactly on the two sides of the body. They are,

For the upper Extremities.—The clavicle, the scapula, the os humeri, the radius, the ulna, the eight bones of the carpus, the five bones of the metacarpus, the two phalanges of the thumb, the three phalanges of each of the fingers, the two, and sometimes more, sesamoid bones—34 for each, 68 in both.

For the lower Extremities.—The os femoris, the tibia, the fibula, the patella, the seven bones of the tarsus, the five of the metatarsus, the two phalanges of the big toe, the three phalanges of each of the smaller toes, and the two, sometimes more, sesamoid bones—32 in each, 64 in both.

There are, therefore, twenty-two bones to the head, not including those of the tympanum; fifty-six to the trunk of the body; one insulated bone to the throat; sixty-eight to the two upper limbs; and sixty-four to the two lower limbs. In all, two hundred and eleven. The redundancy or the deficiency of the sesamoid bones, in a subject, may cause this number to be slightly increased or diminished; the rule is also *variable*, depending upon the particular views of anatomists, for some make but one bone of the os occipitis and the os sphenoides, and others include the teeth.

CHAPTER I.

THE TRUNK.

The trunk is constituted by the Spine, the Thorax, and the Pelvis.

SECT. I.—THE SPINE.

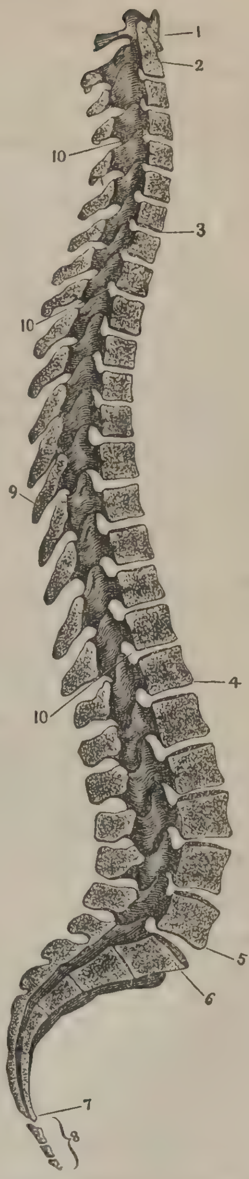
The Spine (Columna Vertebralis, *Rachis*) is placed at the posterior part of the trunk, and extends from the head to the inferior opening

of the pelvis. It consists of twenty-eight or twenty-nine distinct pieces, of which the upper twenty-four are named true, or movable vertebræ, from the twisting motion they execute. The twenty-fifth is the sacrum, or the pelvic vertebra, which is fixed; and the remaining three or four pieces are the caudal vertebræ or the coccyx. The sacrum and the coccyx are called false vertebræ, from not turning.

There are seven vertebræ to the neck, designated Cervical; twelve to the thorax, called Dorsal; and five to the loins named Lumbar. In numbering the vertebræ, the one next to the occiput is always the first; and so on, successively, to the last. Albinus, however, has departed from this rule, and counts them from below upwards.

On the posterior face of the spine, each of the true vertebræ is seen to contribute, by a long process, to that ridge which is so readily felt beneath the skin, and from which, probably, the name of spine was derived. The spine increases gradually in size from the first to the last true vertebra. The upper part of the sacrum is extended laterally much beyond the latter, afterwards the spine diminishes abruptly to the extremity of the coccyx. The spine has several curvatures, which are best marked in the erect position. For example, the lower part of the cervical portion is convex anteriorly, and concave behind; the thoracic part is concave in front, and convex behind; the lumbar portion is convex in front, and concave behind; the pelvic and caudal portion is concave in front, and convex behind. This arrangement is the result of the different degrees of thickness in the bodies of the vertebræ, and especially in the fibro-cartilages which unite them to each other. Wherever these cartilages are thin at their anterior margin, there is a concavity; but where they are thick at the same point, there is a convexity.

Fig. 20.



The middle plane of the Spinal Column, showing its curvatures and internal structure.—1. Atlas. 2. Dentata. 3. Seventh cervical vertebra. 4. Twelfth dorsal vertebra. 5. Fifth lumbar vertebra. 6. First piece of sacrum. 7. Last piece of sacrum. 8. Coccyx. 9. A spinous process. 10, 10. Intervertebral foramina.

General Characters of a Vertebra.

A vertebra (*vertèbre*) consists, in a body, in seven processes or extremities, and in a canal or foramen for lodging the spinal marrow.

The body of a vertebra is at its fore part; its circumference is cylindroid or oval, but varies considerably from these figures according to its position in the spine. The anterior part of the body is convex; but the posterior part is concave, where it contributes to the spinal canal. The superior and inferior surfaces are flat, with the exception of a ridge of hard bone at the circumference, more elevated, and not so extended in some bones as in others. These ridges are, in young subjects, epiphyses. There are many foramina, large and small, to be seen on the front and back surfaces of the bodies. They transmit arteries and veins, and are also used for fastening the ligaments of the spine. On the posterior face of the body there are two foramina larger than the others, and disposed to have a common outlet; they are occupied by veins coming from the interior of the vertebra. These veins correspond with the diploic sinuses in the head, and have been particularly described by M. Breschet, of Paris, in a thesis presented to the School of Medicine, in 1819.

The processes are placed at the posterior part of a vertebra. Of these there are four oblique or articulating processes, two above and two below, which articulate with the corresponding ones of the adjoining bones, above and below; two transverse processes, which project, one on either side, from between the oblique processes; and one spinous process, which is placed on the middle of the bone behind. The two oblique, and the transverse processes on each side, come from a common base or root that arises from the lateral posterior part of the body, and they present collectively a very irregular appearance. Their faces and inclinations are much modified in the several vertebræ. The spinous process is also much modified in regard to size, shape, and inclination.

The body and processes form the periphery of the foramen for the spinal marrow, and, by their thickness and strength, afford an excellent protection to the latter. This spinal foramen is of a rounded cylindrical, or of a triangular prismatic shape, presenting its base in front and its apex behind. It is, for the most part, considerably larger than the spinal marrow of the part, including its vessels, membranes, and the nerves that proceed from it; in this respect, the foramen differs very materially from the cavity of the cranium, which is exactly filled by the brain.

At the upper part of the spinal foramen of a vertebra, between the body and the upper articulating, or oblique process, is a groove or notch. There is another groove between the lower oblique process and the body. These grooves, by the approximation of the contiguous vertebræ, are converted into perfect holes, called inter-vertebral foramina, and are for the transmission of the spinal nerves and blood-vessels.

The bodies of the vertebræ are extremely light and spongy, being

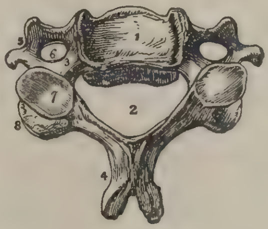
formed principally of the cellular texture or matter of bone, and are covered with a very thin lamella of compact substance, with the exception of their upper and lower surfaces, where this covering is thick at the circumference, owing to the epiphyses. The processes, for the most part, have a thick and compact structure, enabling them to sustain conveniently the weight of the body and the action of the different muscles, as applied to them.

Of the Cervical Vertebræ.

Common Characters.—The cervical vertebræ differ among themselves, but are easily distinguished from the other bones of the spine. Thus their bodies and processes are small, but the spinal foramen is prismatic and large, so as to admit of much motion, without pressing on the spinal marrow. The fore and back parts of the body are more flattened. The upper face is concave transversely, being bounded on each side by a ridge of bone; the lower face is concave from before backwards, and is bounded by a ridge before and behind. This arrangement permits the bodies of adjoining vertebræ to embrace each other in the dried bones, grants great facility of motion, in the living body, by the interposition of a thick inter-vertebral substance, and obtains security in the attachment of the latter.

The oblique processes have their articular faces at an angle of about forty-five degrees; the superior face upwards and backwards, the infe-

Fig. 21.



The general characters of a Cervical Vertebra.—1. Upper face of the body. 2. Spinal canal. 3. Half of an intervertebral foramen. 4. Bifid spinous process. 5. Bifid transverse process. 6. Vertebral foramen. 7. Superior oblique process. 8. Inferior oblique process.

rior downwards and forwards. The spinous process is short, triangular, nearly horizontal, or slightly inclined downwards, and bifurcated at its posterior extremity, where it terminates in one or two tubercles. The transverse processes are short, and perforated by a large canal for the transmission of the vertebral artery and vein; they are excavated above, somewhat convex below, and present two points at their external extremities for the origin and insertion of muscles. The inter-vertebral foramen is formed principally by the lower of the two contiguous vertebræ, but the difference in the contribution of the two is inconsiderable, and is liable to variations in different skeletons, and, indeed, on the bones of the same set.

Of the Cervical Vertebræ, individually.

The first cervical vertebra, commonly called the *Atlas*, from its supporting the head, presents the appearance of a large irregular ring much thicker at its sides than elsewhere. It is defective in body, owing to the space allotted to that part in the other vertebræ being occupied by the processus dentatus of the second vertebra. The body is represented by an arch of bone.

Its oblique processes are peculiar both in shape and position. The upper ones are concave and horizontal, their long diameters being extended from within outwards and backwards, so as to suit the direction of the condyles of the occipital bone with which they articulate; the greatest depth of their concavity is, therefore, internal. The inferior oblique processes are smaller, slightly concave, and circular; they rest upon the shoulders of the second vertebra. At the internal margin of the oblique processes, a rounded tubercle is found on either side of the bone. The transverse ligament of this vertebra is extended between the two tubercles, and keeps the processus dentatus in its place.

The short thin bridge, or arch, at the fore part of the bone, is marked in front by a tubercle and behind by an articular face which touches the processus dentatus. The bridge, or section of the ring forming the posterior part of the bone, is much longer and more arched than the anterior. It also has in its centre a tubercle, occupying the position of a spinous process. At the anterior extremity of this bridge, just behind the upper oblique process, there is a groove, and sometimes a canal, made by the vertebral vessels just before they enter the foramen magnum occipitis.

The transverse processes of this vertebra are at the sides of the thick part of the ring. From their greater length, they project considerably beyond the transverse processes below, and are also perforated at their bases by the vertebral vessels, which have a very winding course from them into the cranium.

The spinal canal of the first vertebra, excluding the space for the processus dentatus and transverse ligament, is the largest in the spine; by which ample provision is made against injuries of the medulla spinalis, notwithstanding the great latitude of the rotation of this bone upon the second vertebra. A considerable vacuity is left between the upper posterior margin of the atlas and the contiguous surface of the os occipitis, for the ginglymoid motion of the head upon the atlas.

The second vertebra of the neck (*vert. dentata*) is particularly remarkable for the elongation of its body above into the processus dentatus or tooth-like process. This process rises as high as the superior margin of the atlas, and almost touches the anterior margin of the foramen magnum occipitis.[1] It presents an articular face in front where it touches the first vertebra. It presents also a smooth face behind where it touches the transverse ligament. Above the latter face, on each side, is a flat surface for the origin of the moderator ligament, and the

[1] Sometimes it even forms a joint with it.

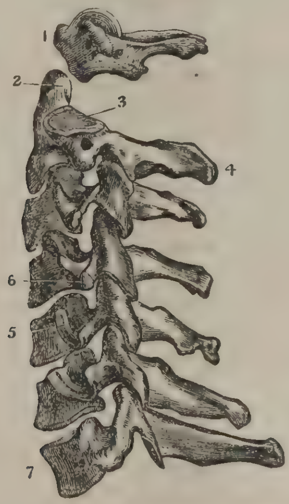
very point above presents a small rough surface for the vertical ligament going to the margin of the foramen magnum.

On each side of the tooth-like process, this bone presents its superior oblique process, as a shoulder, nearly horizontal, circular, and somewhat convex. The inferior oblique process has nothing peculiar either in its position or direction. The foramen of the transverse process is directed upwards and outwards. The interior part of the body, like that of the other vertebræ, is cellular.

The posterior part of the second vertebra is strong and broad. The spinous process is longer than any other, except the seventh and sometimes the sixth: it is also much larger, is triangular, presents a ridge above and a fossa below, and is bifurcated at its extremity. Just behind the upper oblique process there is a very superficial notch, scarcely discernible for the inter-vertebral foramen which transmits the first cervical nerve. The processus dentatus is the pivot or axle upon which the head revolves, and is stationary while such motions are going on. The spinal canal of this vertebra is cordiform or circular instead of triangular.

The vertebræ of the neck increase gradually in the size of their bodies from the second to the seventh, inclusive; and there is sufficient uniformity between them, with the exception of the last, to render the general description applicable, though it is not difficult to observe some minute and unimportant points of difference.

Fig. 22.



A lateral view of the Cervical Vertebræ.—1. Atlas. 2. Processus dentatus of the second vertebra. 3. Its superior oblique process. 4. Its spinous process. 5, 6. Upper and lower oblique processes, showing their inclination. 7. Last cervical vertebra.

The spinous process of the sixth vertebra is long, and terminates in a sharp point frequently.

The seventh cervical (*vertebra prominens*) looks like a dorsal vertebra, and has some peculiarities which are well marked. Its body is larger,

its superior face is less concave than in the others, and its inferior face is flat. Its spinous process is the longest of all, is not bifurcated, but terminates by a rounded tubercle easily felt beneath the skin. Its transverse processes are thrown somewhat backwards, and though there is a small foramen in them, it is not large enough to receive the vertebral vessels. Sometimes on the side of its body, at the lower margin, is a small face, by which it partially articulates with the head of the first rib.

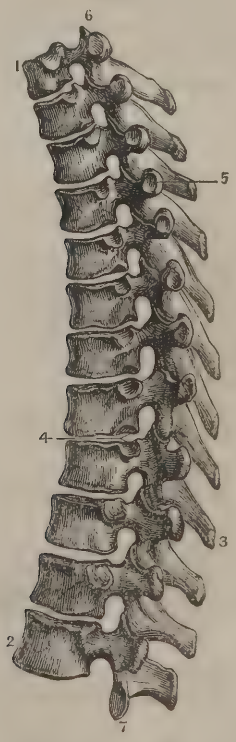
M. Portal[1] reports that in some rare cases he has seen only six, and in others, eight cervical vertebræ; either of which deviations I have never met with.

Of the Dorsal Vertebræ.

General or Common Characters.—The dorsal vertebræ, amounting to twelve, being intermediate in position to those of the neck and loins, are also intermediate in size.

Their bodies are more cylindroid than those of the neck, and the most of them are marked laterally on the upper, and also on the lower

Fig. 23.



A lateral view of the twelve Dorsal Vertebræ.—1. First dorsal vertebra. 2. Twelfth dorsal vertebra. 3. A spinous process. 4. Articulating face for the head of a rib. 5. Articulating face for the tubercle of a rib. 6. Superior oblique process. 7. Inferior oblique process.

[1] Anat. Médicale, Paris, 1803.

margins, near the base of the processes, with a small articular face, which receives one-half of the head of the adjoining rib. The adjoining fossa of the contiguous vertebræ receives the other half of the head of the same rib.

The superior of these articular faces is larger than the inferior. The superior oblique processes are flat, and present almost backwards; the inferior are also flat and present as directly forwards. The transverse processes are directed diagonally backwards: they are long, terminate in an enlarged extremity, which presents an articular face in front for the tubercle of the contiguous rib. The spinous processes are long, triangular, with a broad base, and an extremity somewhat rough, swollen, and sharp-pointed, except in the upper and lower vertebræ: they have a ridge above and a fossa below; are directed obliquely downwards, and overlap each other.

The spinal foramen is small and round. The notch for the intervertebral foramen is formed principally by the upper of the two contiguous vertebræ.

Of the Dorsal Vertebræ—individually.

These vertebræ diminish in the transverse diameter of their bodies from the first to the third; afterwards, they increase regularly in size to the last. The transverse processes of the vertebræ below are directed more backwards, and diminish in length. Though these vertebræ have many common points of resemblance, yet some of them present distinguishing peculiarities. Of which, the first and the two or three last, are the most remarkable examples.

The first has a complete articular face on the side of its body for the head of the first rib, and a partial surface at its lower margin for the head of the second rib. Its spinous process is projecting and does not present so obliquely downwards as some of the others: the flatness of its body makes it look much like a cervical vertebra.

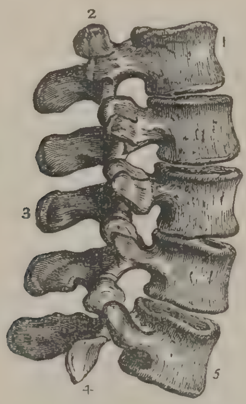
The three lower dorsal vertebræ approach in the form of their bodies to those of the loins. Frequently, but not always, the tenth has the articular face for the head of the rib equi-distant from its upper and lower margins, and its transverse process so short, and inclined backwards, that the tubercle of the tenth rib does not form an articulation with it. The eleventh and twelfth vertebræ have the fossæ for the heads of the ribs, in their middle, at the sides of the roots of the processes, instead of a partial pit at their upper and lower margins. Their transverse processes are remarkably short, are directed almost backwards, and do not touch the ribs, and have, therefore, no articular marks. The spinous process departs from the triangular shape, becomes flattened and vertical at its sides, is not far from being horizontal, and has a tubercle at its extremity.

The middle vertebræ of the back have some minute points of difference among themselves, the most of which it would be useless to study. Their spinous processes are very near to, and overlap each other, like shingles on the roof of a house.

Of the Lumbar Vertebræ.

Common Characters.—Their number has been stated at five. Their bodies are larger than those of the other true vertebræ, and are of an oval outline on the upper and lower surfaces, with the long diameter transverse. The epiphyses at the margins of these faces are larger and more elevated. The spinal foramen is triangular and more capacious than in the dorsal vertebræ. The inter-vertebral notches for the

Fig. 24.



A lateral view of the five Lumbar Vertebræ.—1. First lumbar. 2. Superior oblique process. 3. Spinous process. 4. Inferior oblique process. 5. Last lumbar vertebra.

nerves to pass out, are much larger than elsewhere in the spine, and are formed principally by the upper of the two contiguous vertebræ.

The transverse processes are very long, and stand out nearly at right angles to the body. The articular faces of the upper oblique processes are concave and vertical, being directed very much inwards, or looking towards each other; the lower oblique processes are convex, and have the articular faces directed very much outwardly. The spinous process is short, thick, and horizontal; having broad, flat sides, and terminating by an oblong tubercle somewhat bifid below.

Of the Lumbar Vertebræ, individually.

These bones are not so well marked among themselves as the other vertebræ. They may be distinguished in a single set, by the successive increase in the size of their bodies. The first, therefore, is known by its being the smaller, by the comparative shortness of its transverse process, and by the deep concavity between the superior oblique processes.

The transverse and spinous processes of the three middle vertebræ are rather longer than those of the others; the third has them the longest of all. The last lumbar vertebra may be recognized by its

greater size; by its body being flat, and thicker in front than behind, so as to give it somewhat of a wedge shape; by the greater size of its spinal foramen; by the obliquity backwards of the transverse process; and by the wide interval between the oblique processes, as well as by the lower of the latter facing almost directly forwards.

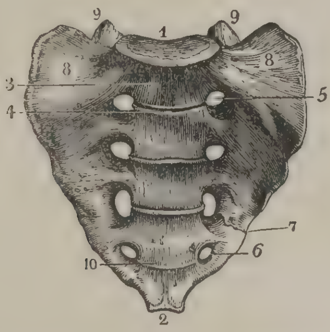
Of the Pelvic Vertebræ.

The os sacrum (*sacrum*), the largest by much of any of the bones in the spinal column, has obtained its name from the supposition of its having been offered in sacrifice by the ancients.[1] It forms the posterior and superior boundary of the pelvis, as well as the pedestal of the spine, and may, therefore, be properly studied along with either of them, though its association with the spine is more natural. In its lateral boundaries it is triangular: it is also regularly concave before, and very irregularly convex behind.

In its forming state, this bone consists of five pieces, separated by long narrow interstices filled with cartilage. It is in this condition that its pieces bear strong resemblance to the true vertebræ, and, therefore, have obtained the name of false vertebræ. They are all joined into one by the progress and development of the bone; but the marks of the original separation remain, particularly on its front surface.

Though the anterior face of the sacrum generally presents a regular concavity, in some subjects it is almost flat. This surface is pierced on each side by four holes, which communicate with the spinal cavity

Fig. 25.



An anterior view of the Sacrum. 1. Articular face for the last lumbar vertebra. 2. Articular face for the coccyx. 3. Promontory of the sacrum. 4. Line marking the former pieces of the sacrum. 5. The first sacral foramen. 6. The fourth sacral foramen. 7. A portion of the sacro-sciatic notch. 8. Wing of the sacrum. 9. Oblique processes for articulating with the last lumbar vertebra. 10. Line of separation of the last pieces of the bone.

and transmit the anterior nerves of the cauda equina. Beneath each range of holes is a notch, which, by the corresponding one of the coccyx, is converted occasionally into a perfect foramen for the thirtieth spinal nerve, or for the fifth of the sacrum. These foramina

[1] Portal, Anat. Med. vol. i. 345.

diminish in size, from the higher to the lower: their orifices are funnel-shaped, and directed obliquely outwards. Horizontal ridges of bone, marking the original separation of the false vertebræ, connect the holes of the two sides.

The false vertebræ decrease in size from above, which is manifested by the successive approach of the foramina, and of the horizontal ridges. The first of them has almost the same vertical diameter as the last of the loins, and sometimes a greater one, especially in the male subject; besides its large increase of magnitude by the lateral extension of its base.

The posterior face of the sacrum is very convex and rough, and is equally divided by its spinous processes. The processes belonging to its three upper sections or bones are for the most part well marked, and decrease in length from the first. The fourth spinous process is resolved into two tubercles, connected at their base, and the fifth is fully separated into two tubercles, by an angular fissure, with its base downwards and open. This fissure, it may be remarked, sometimes invades the fourth spinous process, and even the third, and in some rare cases runs the whole length of the posterior surface of the bone, leaving a gap from one end to the other. The upper margin of the posterior face of the sacrum, or its first bone, presents on each side an oblique process for articulating with the lower oblique processes of the last lumbar vertebra. Just above the upper spinous process is a deep notch, between which and the last lumbar vertebra is a very large vacuity, or gap, exposing the spinal canal.

On each side of the spinous processes are also four foramina, smaller and thinner than those in front, for the passing of the posterior nervous cords from the cauda equina. At their internal margins some small and obscure risings of bone are perceptible, which may be considered the rudiments of oblique processes. On the outer side of these foramina, there are several more strongly marked tubercles, corresponding with the transverse processes of the true vertebræ, and from which the sacro-iliac ligaments arise. Beyond these the posterior surface of the bone slants very considerably to its lateral margin; the entire surface of this slant, which is irregularly pitted, being devoted to the origin of ligamentous matter connecting it with the ilium.

The base of the sacrum presents in its middle an oval surface for articulating with the body of the last lumbar vertebra. Between this surface and the oblique process may be remarked the groove for the fifth lumbar nerve. The base of the sacrum continually thickens, from the side of the oval surface to the place of junction with the ilium. The anterior margin of this expansion is continuous with the linea ilio-pectinea; the posterior margin is elevated at its extremity, is a substitute for a transverse process, and is placed immediately below the transverse process of the last lumbar vertebra. The point of the sacrum is truncated where it articulates with the os coccygis.

The lateral face of the sacrum is thicker above than below; its upper two-thirds present an irregular and somewhat triangular articular face for joining the ilium; the lower third is very thin, and contributes to form the sacro-sciatic notch of the pelvis.

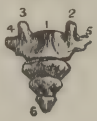
The spinal canal of the sacrum is triangular, and diminishes continually to its lower extremity, where it terminates by a small orifice, notched behind, as mentioned, and exposing the last piece of the bone. The foramina on the anterior and posterior surface of the sacrum, communicating with this canal, correspond strictly in their uses and positions with the inter-vertebral foramina of other parts of the spine.

The sacrum is extremely light for its size, and its texture is in a high degree spongy; but its processes and articular faces are quite as compact as they are in other parts of the spine.

Of the Coccyx or Caudal Vertebræ.

The os coccygis (*coccyx*) resembles the sacrum in shape and texture, and is so placed as to continue forwards the line of the curvature of the sacrum. It consists in four small pieces, sometimes only three, united

Fig. 26.



The four bones of the Coccyx. 1. First bone. 2, 3. Processes to join the sacrum. 4, 5. The notches to form the foramen for the sixth sacral nerve. 6. The last bone of the coccyx.

to one another by fibro-cartilaginous matter, and it corresponds with the tails of animals. These pieces, in the progress of life, are not only anchylosed together, but also with the sacrum; so that all the false vertebræ, from the base of the sacrum to the point of the coccyx, are joined into a single bone.

The upper bone of the coccyx is the largest, and is the base of this little pyramidal pile; it is united, by its middle, to the truncated apex of the sacrum, and its sides, moreover, are, in the perfect specimen, elongated several lines beyond this surface of contact. From the posterior surface of the first bone, of the perfect coccyx, a tubercle arises on either side, which is curved upwards, and joins the bifurcated termination of the last spinous process of the sacrum: between the two bones an inter-vertebral foramen is thus left for the passage of the fifth sacral nerve from the canal of the sacrum. Immediately below this tubercle is a notch, made by the sixth sacral nerve.

The remaining bones of the coccyx are much smaller than the first, and diminish successively. The surfaces which they all present to each other are somewhat concave in the centre. The lower end of the last bone terminates in a rough point, to which a cartilage is appended. These bones are very spongy and light: their principal strength is derived from a ligamentous covering. To them are attached the sacro-sciatic ligaments, the coccygæi, levatores ani, and the glutæi magni muscles.

SECT. II.—DEVELOPMENT OF THE VERTEBRAL COLUMN.

This column is much longer, in proportion to the limbs, at birth, than it is in adult life, and upon it depends the principal length of the individual at this period. The head is always in proportion to the length of the spine. This predominance in the head and spine is, no doubt, connected with the necessity of an early development in the nervous, respiratory, and alimentary systems, in order to maintain the life of the individual; whereas, the use of the upper and lower extremities being called for only at a more advanced period, their development is not in proportion. It is remarked, that in adult life the principal difference in the stature of individuals depends upon the length of the lower extremities; the trunk, including the head, being of nearly the same length in all. This rule, however, like most others, has numerous exceptions. The spinal canal and the inter-vertebral foramina are, also, proportionably larger in the fœtus.

The spine of the fœtus is but badly suited to the purposes of standing and walking. Its spinous processes are deficient, in consequence of which, the muscles which are intended to keep it erect have their insertions so much in the line of motion, that they perform their part very imperfectly, and the spine is continually bending forward from the erect position. All the transverse processes are also imperfectly developed, those of the loins are particularly deficient; those of the thorax and neck are less deficient, as in the one case they have to form an articular surface for the ribs, and in the other to allow passage to the vertebral artery. The bodies of the vertebræ are imperfectly ossified, and are separated by cartilage from the processes. The epiphyses, or upper and lower surfaces of the bodies, are in the state of cartilage: the bodies, therefore, are rounded both above and below, whereby their surfaces of contact are much reduced in extent, and the line of support to the trunk rendered much less firm. When, at this age, the vertebræ are macerated, their bodies present themselves as small rounded tubercles; and very nearly one-half the whole length of the spine is made up of the cartilaginous epiphyses and the inter-vertebral cartilages. The spine, in the fœtus, is almost straight, and scarcely presents at all those curvatures for which it is so remarkable in adult life. This depends upon the rounded form of the bodies of the vertebræ, and the sameness of thickness in the inter-vertebral matter at its anterior and posterior edge.

SECT. III.—ON THE USES OF THE VERTEBRAL COLUMN.

The vertebral column performs three important offices in the animal economy. It affords a secure lodgment to the spinal marrow; is a line of support to the trunk, in every variety of position; and is the centre of all its movements.

In standing, the spine also supports the head, which it can do very conveniently, from the horizontal direction of the condyles and their nearly central position on the occiput, and from the head being almost

in equilibrium when we stand erect. The volume of the head is so much greater before the condyles than behind them, that upon a superficial view one would suppose its preponderance in front to be very considerable. This is, however, less than it might seem to be, for two reasons: one is, that the diameters of the head are augmented behind the condyles, and, secondly, it is formed of solid matter there; whereas, in front a great deal of it is hollow, for the construction of the nose and the sinuses bordering upon it. The head, though nearly balanced then, has some preponderance in front, which is manifested by its falling forwards whenever we sleep in the erect position, or when the sudden suspension of life destroys the contraction of the muscles on the back of the neck.

In the lower orders of animals, the obliquity of the condyles, their situation at one end of the head, and the great length of the face, acting as a weight upon a long lever, have a continual tendency to incline the head downwards, which is only partially counteracted by the largeness of the muscles and ligaments on the back of the neck.

The horizontal direction of the condyles, and their location near the centre of the base of the head, have arrested the attention of naturalists, and established for man characters distinguishing him from all other animals, for facility in maintaining the erect attitude. Bichat happily observes, that from this conformation result the following peculiarities in his organization: 1. Less strength in the muscles of the neck than in quadrupeds; 2. Less projection in the occipital bone, where the muscles are inserted; and, 3. An imperfect development of the ligamentum nuchæ.

The thoracic and abdominal viscera, by being placed in front of the spine, and without a counterpoise behind, have a continued tendency to bend it. This is only resisted by the muscles which fill up the long gutter on either side of the spinous processes, and are inserted into the ribs, the spinous and the transverse processes. The lumbar vertebræ and the appertaining muscles and ligaments, having an increased duty to perform, from the lowness of their position, and the variety of their movements, become the soonest affected by fatigue and bodily weakness, and therefore manifest sooner the sensation of lassitude, notwithstanding the augmented volume of the bodies and processes of these vertebræ, and of the muscular masses inserted into them.

The mechanical arrangement of the spine permits it to perform the motions of flexion, extension, lateral bending, circumduction, and rotation.

1. Flexion, or that posture in which the spine is bent forwards, is the most extensive of its movements; the general mechanism of the human body disposes us to approach surrounding objects in that direction; and the muscles of the abdomen, besides their intrinsic strength, act most advantageously in producing it, by being removed to a great distance from the centre or line of motion. In this position the inter-vertebral cartilages are diminished or compressed in front, and thickened behind; the anterior vertebral ligament is in a state of relaxation, while the posterior vertebral ligament, the elastic, and

those which connect the spinous processes, are in a state of proportionate tension.

2. The motion of extension, on the contrary, is much more limited from several causes. The muscles which act in this case, by arising either from the posterior face of the pelvis, or from the transverse processes, and going upwards to be inserted either into the ribs, the transverse or the spinous processes, are much less advantageously placed than the abdominal muscles, in regard to the length of the lever which they employ. Moreover, mechanical obstruction is opposed to this motion by the spinous processes of the back and neck, being very near to and overlapping each other. The abdominal muscles also afford a strong resistance to its being carried beyond a certain point as any one may assure himself of, by the tension communicated to these muscles from placing a large billet of wood under the loins of a subject; and, when they are cut through transversely, the immediate consequence is a great increase in the posterior flexion of the spine, through the agency of the lower dorsal and the lumbar vertebræ. The anterior vertebral and the inter-vertebral ligaments likewise oppose the extension of the spine much more than the elastic and the inter-spinous ligaments do its flexion.

3. The lateral inclination of the spine is a motion of considerable extent, and is obtained both by the very advantageous position of the muscles on the side of the trunk and neck, and by the little mechanical resistance to it from the shape and arrangement of the parts concerned. A principal impediment to this motion being carried beyond a certain point is presented by the ribs striking against each other. The transverse processes of all the vertebræ are so far apart, particularly in the loins, that they scarcely deserve to enter into the estimate of resistances. As the muscles of the one side produce the lateral curvature, so their resistance on the other limits it to a certain extent, as may be readily ascertained by cutting them through.

4. The circumduction of the spine is that motion in which the trunk is caused to describe a cone, the base of which is above, and the apex below. It is performed on the lower dorsal and the lumbar vertebræ, and is a succession of the movements already described.

5. The rotation of the spine is a very limited motion. It is performed almost entirely on the lower dorsal and the upper lumbar vertebræ, and presents in its analysis a series of minute and oblique slidings of the bodies of the vertebræ upon one another, the pivots being the oblique processes. The action occurs by the lateral yielding of the inter-vertebral substance; it must, therefore, be almost inconceivably small in any individual substance, particularly when the latter has been hardened and rendered more fibrous by old age. In the very young subject it is more appreciable.

Of the Motions peculiar to each Class of Vertebræ.

1. The cervical vertebræ, as a whole, enjoy a considerable share of flexion, extension, lateral inclination: and of circumduction, as the result of the other motions. Their rotation, or the oblique sliding of one vertebra upon the other, is very limited. The apparent facility with which they are twisted upon each other, when the face is turned to the shoulders alternately, is almost wholly the motion of the first vertebra upon the second, the participation of the other vertebræ being very inconsiderable. The possibility of the simple dislocation of these vertebræ, with the exception of the first, is very stoutly denied by authorities of the first standing in anatomy, on the score that too great a resistance to this accident is afforded by the inter-spinal and inter-transverse muscles, by the inter-locking of the bodies of the vertebræ through their reciprocal concavities and convexities, and by the shape and extent of their oblique processes.

Many years ago, I met with a case in which there was every reason to believe that a partial displacement or dislocation had occurred about the fourth vertebra, in a boy of eight or ten years. It arose from his struggling to extricate himself from the grasp of a school-mate, who held him near the ground by the back of the head, with the spine bent forwards. This position, it is evident, was calculated to lift the oblique processes of the vertebræ above, over the others; and an oblique force applied at the same time consummated the accident, by twirling the lower oblique process over the upper margin, and in front of the one with which it was articulated below. The displacement was manifested by inability to move the neck; by a permanent inclination and turn of the head to the side opposed to the injured one; and by an inequality in the range of the anterior points of the transverse processes of the side affected. I succeeded in replacing the bone by lifting its dislocated side over the oblique process of the vertebræ below, communicating at the same moment a rotatory motion, the reverse of that by which the accident had happened. In an instant, the patient was relieved: from extreme pain, fixed deformity, and inability to move the neck, he performed with freedom all the motions natural to the part.[1]

The principal motions of the head upon the first vertebra are those of flexion and extension; the power of the condyles to slide horizontally from one side to the other in the cavities formed in the atlas is narrowly restricted, both by the shape of the proximate articular surfaces, and by the arrangement of the ligaments: this motion is, in fact, so inconsiderable as scarcely to deserve notice. Even flexion and extension appear greater than they actually are, in consequence of the lower vertebræ most commonly concurring in these motions. When simply the head is flexed upon the atlas, while the other vertebræ are kept erect, the chin approaches the sternum, and the skin of the neck is thrown into folds; but when all the bones are flexed, the head is thrown forwards and the skin is kept tense. The flexion of the head upon the atlas is restricted by the ligamentum nuchæ, and by the ligament pass-

[1] I have also seen another accident of a similar kind from a fall. See Med. Examiner, 1842.

ing from the posterior margin of the occipital foramen to the posterior bridge of the atlas. The extension of the head is restricted by the vertical, moderator, and anterior vertebral ligaments.

The motion of the atlas upon the axis is limited strictly to rotation. The confinement of the processus dentatus by the transverse ligament behind, and by the anterior bridge of the first vertebra in front, prevents thoroughly both flexion and extension. The horizontal direction and the flatness of the corresponding articular faces of these two vertebræ also prevent any lateral inclination. In compensation for these restrictions, the rotatory motion is enjoyed to great extent, and is amply provided for, by the extreme looseness and thinness of the capsular ligament of the oblique processes. In this motion the arch of the atlas and the transverse ligament rotate on the tooth-like process to the right and left alternately; at the same time the inferior oblique process of the atlas is slid either forwards or backwards, according to the general movement upon the upper oblique process of the dentata. This movement is checked, at a certain point, by the moderator ligaments, which, by the close connection of the head and first vertebra, answer the same purpose as if they were inserted into the latter. It is also checked by the capsular ligament, notwithstanding the general laxity of the latter. But still it is not difficult for it to exceed its natural bounds, and for the oblique process of the atlas to pass completely beyond the margin of that of the dentata, and in returning to lock against it. This, in fact, happens, in the great majority of instances, where violence from falls, and so on, has been applied to the body, and results in injury to the neck particularly; and when, in the abrupt turning of the head, produced by the action of the muscles, the individual finds himself incapable of bringing it back. This articulation is, unquestionably, less protected, and more exposed to accident, than any other in the spine; and, as just stated, is therefore supposed, by some, to be the only one in the neck admitting of simple luxation.

Most frequently, in this luxation, when it is produced by external violence, death is the immediate result, from the spinal marrow being pressed upon and disorganized above the origin of the phrenic nerve. The seat of the principle of respiration is in the medulla oblongata, and its agents are the phrenic and the intercostal nerves; the communication with which being thus cut off, respiration, and consequently circulation, stop immediately. Bichat thinks, that when death is thus suddenly produced, the processus dentatus, by rupturing its own ligaments connecting it to the occiput, slides by the falling of the head forwards, beneath the transverse ligament, and presses upon the spinal marrow. On the contrary, when it is a simple displacement of the oblique processes, as the odontoid process remains within its boundaries, and its ligaments are only stretched, there is no danger of death. Fatal accidents have happened to this articulation, in holding an infant from the ground, by the two hands applied to the head, from his struggles to disengage himself. A posture-maker is said to have died on the spot, from communicating a rotatory motion to his trunk, while its weight was sustained by inverting his head, and making the latter the base of support. When the vertebræ are displaced in such persons, as well as in those hung by the neck, it is supposed that the sliding of

the processus dentatus from beneath the transverse ligament takes place; as, by experiments on the dead body, it is found that such displacement occurs much more readily than the rupture of the transverse ligament.

2. The dorsal vertebræ are capable of but very little motion in any direction. The rigidity and length of the sternum prevent their flexion; the overlapping and obliquity of their spinous processes prevent their extension, and the ribs prevent their lateral inclination. It is, however, to be observed, that as those obstacles are diminished, successively, in the five lower dorsal vertebræ, they consequently become more and more capable of motion upon each other. Simple luxation among them, at any point, is thought to be impossible, from the strength of their ligamentous attachments, and from the arrangement of their articular faces.

3. The lumbar vertebræ move with great comparative freedom upon one another; admitting, as stated, of flexion, extension, and lateral inclination. Below, however, they are much more restrained than they are above; hence, it results that the principal seat of the motions of the trunk upon the spine is about the connection of the lumbar and dorsal vertebræ. Simple dislocation is here, also, thought to be impossible, from the strength of their ligamentous attachments, from the great diameters of their bodies, and from the deep inter-locking of the oblique processes.

SECT. IV.—OF THE OSSA INNOMINATA.

(*Os Coxaux, ou des Iles.*)—These bones, two in number, are situated one at either side of the sacrum, and constitute the lateral and anterior parietes of the pelvis; forming, along with the sacrum and coccyx, the whole of this latter cavity.

The os innominatum, from having been, in its original state, in three pieces, notwithstanding they subsequently coalesce firmly in the adult, and preserve scarcely any vestige of their primitive distinction, is divided by anatomists into ilium, ischium, and pubes.

Os Ilium (*Ilion*).—This, the largest of the three portions, forms all the upper rounded part of the os innominatum, and is the haunch bone of common language. Its external face is called the *Dorsum*, and the internal face the *Costa* or *Venter*. Its superior margin is a semicircle, rather thicker towards the extremities than in the middle. The inequality, when viewed from above, is very apparent, as well as a slight curvature resembling the letter *S*. This margin of the bone is called its crest or spine, presents an internal lip for the origin of the transversalis abdominis muscle, an external one for the insertion of the obliquus externus, and an intermediate edge for the origin of the obliquus internus. The anterior extremity of the spine is terminated by a projecting point, called the anterior superior spinous process, from which arise the tensor vaginæ femoris, the sartorius, and the beginning

of Poupart's ligament. The posterior extremity of the crest is also projecting and pointed, but less so than the other, and obtains the appellation of the posterior superior spinous process.

The anterior margin of the os ilium is unequal, and divided into two portions of nearly the same length, by a strong, well-marked projection, the anterior inferior spinous process, which is placed an inch and a-half below the anterior superior, and gives origin to the rectus femoris. This margin joins with the pubes by a large flattened elevation, called the ilio-pectineal protuberance. Between the latter and the anterior inferior spinous process, a concavity exists which is occupied by the junction of the psoas magnus and the iliacus internus muscles, where they pass under Poupart's ligament. Between the two anterior spinous processes is another concavity, from which the anterior edge of the gluteus medius arises.

The posterior margin of the ilium is also very unequal, both in its direction and thickness. The posterior inferior spinous process is about sixteen lines below the posterior superior, and terminates a cutting edge running between these two processes. Just below it we find the deep excavation called the sciatic notch.

The exterior face of the ilium, or its dorsum, is generally convex and rounded; its margins, however, are so elevated that partial depressions, or sinkings below the general surface, may be remarked, especially at its back part. Just above the two posterior spinous processes, a flatness is observable, from which a part of the gluteus magnus arises.

Fig. 27.

Outside of the Innominatum of the right side. 1. Dorsum of the ilium. 2. Ischium. 3. Pubes. 4. Crest of the ilium. 5. Surface for the gluteus medius. 6. Surface for the gluteus minimus. 7. Surface for the gluteus magnus. 8. Anterior superior spinous process. 9. Anterior inferior spinous process. 10. Posterior superior spinous process. 11. Posterior inferior spinous process. 12. Spine of the ischium. 13. Greater sciatic notch. 14. Lesser sciatic notch. 15. Tuber ischii. 16. Ramus of the ischium. 17. Body of the pubes. 18. Ramus of the pubes. 19. Acetabulum. 20. Thyroid foramen.

A semicircular rough ridge begins at or near the anterior superior spinous process, and may be traced on this surface of the bone to the

sciatic notch. All that portion of the dorsum between this ridge and the crest of the bone, with the exception of the little flat surface just above the posterior spinous processes, gives origin to the gluteus medius. The dorsum terminates below at the acetabulum, and between the latter and the semicircular ridge is the surface for the origin of the gluteus minimus.

The internal face of the ilium, or that portion which looks towards the belly, being called the costa or venter, is in its superior part, amounting to about two-thirds of the whole surface, very concave. This is the *iliac fossa*, which is occupied by the iliacus internus muscle. The fossa is continued forwards into the hollow below the anterior inferior spinous process, and over the acetabulum. The iliac fossa is terminated below

Fig. 28.

Inside of the Innominatum of the right side. 1. Surface for the sacro-iliac ligaments. 2. Ischium. 3. Body of pubes. 4. Anterior superior spinous process. 5. Anterior inferior spinous process. 6. Posterior superior spinous process. 7. Posterior inferior spinous process. 8. Sciatic notch. 9. Plane of the ischium. 10. Iliac fossa. 11. The portion of the venter which is continuous with the wing of the sacrum. 12. Linea ilio-pectinea. 13. Spine of ischium. 14. Tuber ischii. 15. Line of attachment of the greater sacro-sciatic ligament. 16. Line of attachment of the erector penis, or clitoridis muscle. 17. Symphysis pubis. 18. Ilio-pectineal protuberance or boss. 19. Groove for the obturator vessels and nerve. 20. Foramen thyroideum.

by a rounded ridge, a part of the linea ilio-pectinea that separates the greater from the lesser pelvis. The remaining third of the costa of the ilium is very rough and unequal, and is appropriated to the articulation with the sacrum, and to the origin of some of the muscles of the back. Immediately posterior to the sciatic notch is the surface for the sacrum, which is somewhat triangular, but irregularly so, and extends from the iliac fossa to the posterior inferior spinous process. Behind the sacral surface is another, twice as large, strongly marked by its roughness, and elevated into a vertical ridge near its middle. Anterior to this ridge arise many of the ligamentous fibres, fastening the ilium to the sacrum; but posterior to it is the surface for the origin of the multifidus spinæ and the sacro-lumbalis muscle.

Os Pubis (*Pubis*).—This bone constitutes the fore part of the innominatum, and is much the smallest of the three. It is composed of a

body and two large branches from it, one running downwards to join the ischium, and the other backwards and upwards to join the ilium.

The body of the pubes is joined to its fellow on the opposite side by a flat surface, called the symphysis, which is eighteen or twenty lines in its long diameter. The superior part of the body also presents a flat surface, called its horizontal portion, which is bounded outwardly by the spinous process about an inch from the symphysis. The horizontal portion and the symphysis form a right angle. From the exterior face of the spinous process two ridges proceed outwardly; the posterior is the crista; it is frequently sharp, elevated, and makes the anterior half of the linea ilio-pectinea; the anterior ridge is lower down, increases in its elevation as it goes along, is rounded, and runs nearly horizontally to terminate in the anterior upper margin of the acetabulum. Between the two ridges is a superficial triangular concavity occupied by the origin of the pectineus muscle; the base of the triangle is bounded by the protuberance formed at the junction of the pubes and ilium, and it is exactly over this part that the femoral vessels pass; its apex is the spine or spinous process of the pubes. The extremity of the upper branch of the pubes is triangular, and much enlarged where it contributes to the acetabulum.

The inferior branch of the pubes, technically called its *ramus*, is a flattened process about an inch in length, and, as mentioned, descends to join the ischium. Its exterior is plain, and has no mark deserving of attention; but the internal face, near the anterior margin, is concave for attaching the crus of the penis, or of the clitoris.

The body of the pubes in front is concave, and gives origin to the adductor longus and brevis muscles: behind, it is only sufficiently concave to participate in the general concavity of the pelvis.

Os Ischium, (*Ischion.*)—This bone forms the posterior inferior portion of the os innominatum, and is the next in size to the ilium. It is of a triangular form, and has the anterior extremity bent upwards to join with the pubes. The latter part is its *crus* or *ramus*, and the remainder is its body.

The body of the ischium is a triangular pyramid, the internal side of which is smooth and uniform, but the posterior and the external sides are very unequal. The internal side is broad above and narrow below; at the middle of its posterior margin is the spinous process, a projection of considerable magnitude, and sharp-pointed, for attaching the lesser sacro-sciatic ligament. Immediately below the spinous process is a smooth concave surface, forming a trochlea, over which the obturator internus muscle plays. Below this trochlea, and forming the most inferior internal margin of the bone, is a long ridge, somewhat more elevated behind than in front, into which the great sacro-sciatic ligament is inserted. The internal face of the ischium, though technically called its *plane*, departs from the perfect regularity implied in that name, by participating in the general concavity of the pelvis.

The posterior face of the ischium is swollen out, above, into a rounded surface, for the strengthening of the posterior parietes of the acetabulum. This swell is bounded, below, by a transverse depression or fossa; immediately below which, is the tuberosity of the ischium, a large rough surface extending from the fossa to the beginning of the crus.

This rough surface is subdivided into four, two above, and two below. The one above, which is external, and nearest to the acetabulum, gives origin to the semi-membranosus muscle; the other, which is internal, gives origin to the semi-tendinosus, and to the long head of the biceps flexor cruris. Of the two flat surfaces below, the one which borders on the ridge for the insertion of the great sacro-sciatic ligament, and naturally covered with cartilage, is the part on which we sit; and the last surface, which is exterior again to this, gives origin to a part of the adductor magnus muscle.

The *exterior* face of the ischium, above, forms the lower part of the acetabulum, and is, therefore, very much excavated; below this, the surface is flat, and sufficiently uniform to dispense with a particular description.

The crus of the ischium is flattened internally and externally, and in the adult it is fused completely into the crus of the pubes, so that very faint marks of their primitive separation are left. The anterior margin of the crus has an excavation continuous with that on the crus of the pubes, for the origin of the crus penis and the erector penis muscle.

In examining the general features of the os innominatum, it will be observed, that its outline is in some degree like the figure 8; the narrowing in its centre being produced by the sciatic notch below, and by the deep concavity above, between the anterior superior spinous process and the symphysis of the pubes. The regularly rounded margin of the ilium above, and of the ischium below, contribute to the resemblance, but the angle of the pubes interrupts it. The narrowest part of the bone, or its neck, is between the top of the sciatic notch and the fossa below the anterior inferior spinous process. It will also be remarked, that the posterior margin of the sciatic notch is formed by the ilium, and the anterior by the ischium.

The acetabulum, or the cotyloid cavity (*cavité cotyloide*), is placed immediately on the outside of the neck of the os innominatum. In infancy one-fifth of it is seen to be made by the pubes, two-fifths by the ilium, and two-fifths by the ischium. It is a very deep hemispherical depression, having a sharp elevated margin all around, particularly at its superior part. The inferior margin, amounting to one-eighth of the whole circumference, is comparatively shallow, and is, indeed, converted into a notch (*incisura acetabuli*), sunk much below the general surface of the brim. The greater part of the acetabulum is smooth, and incrusted with cartilage wherever the head of the os femoris is applied to the support of the trunk; but the very bottom (*fovea acetabuli*), with the intervening surface continuous with the notch, amounting to rather more than one-fourth of the whole cavity, is rough, sunk below the general concavity, and is occupied by a soft vascular fat.

In the fore part of the innominatum a large deficiency, called the thyroid foramen (*foramen thyroideum*), exists between the pubes and ischium. In the male subject it is triangular, with the angles rounded; but in the female it is rather oval. Leading from the plane of the ischium is a groove, which goes along the superior end of the foramen, and appears externally under the anterior ridge of the pubes. It conducts the obturator vessels and nerve to the inner side of the thigh.

The texture of the os innominatum is cellular within, with a condensed lamella externally. It is of very various thickness. The ilium, in its centre, has the dorsal or the external and the ventral or internal sides so near one another, that in most adults the light will shine through them. A large foramen is seen on the venter of the ilium, and another on its dorsum, for the transmission of nutritious arteries. There are several others, smaller, at various points of the os innominatum, for the same purpose, and for the adhesion of ligamentous fibres.

SECT. V.—OF THE PELVIS GENERALLY.

The sacrum and coccyx behind, and the ossa innominata at the sides and in front, constitute, as observed, the whole cavity called pelvis (*bassin*). Its position is such, that, in the adult, it divides the entire length of the body into two parts nearly equal, the head and trunk forming one part, and the lower extremities the other. Generally, the former are somewhat the longer; but in cases of unusual corporeal stature, the excess depends upon an undue length of the inferior extremities. On the contrary, in persons of little height, the latter have not been developed in proportion to the trunk of the body.

The pelvis, as a whole, is a conoidal cavity, having its base upwards, and the summit below. Its internal surface forms an irregular floor, on which the viscera of the abdomen are sustained in the erect position; and its external surface, by projecting considerably at various places, establishes very favorable points for the attachment of muscles.

The internal surface of the pelvis is divided by the projection of the anterior margin of the base of the sacrum, and by the linea ilio-pectinea, into two cavities; the upper one is the great pelvis, and the lower one the lesser pelvis. The great pelvis is the base of the cone, and presents at its anterior part a large deficiency, which is supplied in the fresh subject by the abdominal muscles. The lesser pelvis is a complete bony canal, much deeper behind and at the sides than in front. Its depth, behind, is formed by the whole length of the sacrum and coccyx; at the sides by the bodies of the ischia and a small part of the ilia; and, in front, only by the length of the bodies of the pubes.

The upper orifice of the lesser pelvis is called the superior strait; it is somewhat oval, and looks obliquely forwards and upwards. Its axis may be indicated by a line drawn from the extremity of the coccyx to a point an inch, or thereabouts, below the umbilicus. The inferior orifice of the lesser pelvis is called the inferior strait. Its margins in the naked skeleton are very unequal, for it presents three very deep notches, two lateral, and one in front. The first are formed by the external margins of the sacrum and coccyx, contributing to deepen the sciatic notch, which already is formed in each innominatum. The third one is formed by the convergence of the rami of the pubes and ischia of the opposite sides, and constitutes the arch of the pelvis of authors, sometimes called the arch of the pubes. The axis of the lower strait, it is clear, must have a very different direction from the axis of the superior, and is indicated by a line drawn from the lower part of

the first bone of the sacrum, through the centre of this opening. The cavity of the lesser pelvis is increased considerably behind, by the curvature of the sacrum; this, however, is not uniform, as the sacrum is much more curved, as well as longer in some individuals than in others. The planes of the ischia are not parallel with one another, but converge slightly from above, in consequence of which the transverse diameter of the lower strait is rather smaller than the transverse diameter of the superior strait.

Difference of the Pelvis in the Male and the Female.

There are several well-marked peculiarities, in the fully developed pelvis of either sex.

The ossa ilia are larger, less concave, and more horizontal in the female. The superior strait is also larger, and more round: its transverse diameter always exceeds the antero-posterior; whereas of the two, the latter, in the male, is generally found the longer. The lesser pelvis is also more capacious in women. The crura of the pubes and ischia are not so long as in men; but they diverge more, and join at the under part of the symphysis pubis by a large, regularly rounded arch; whereas, in men, the arch, as it is called, is merely an acute angle.

The os sacrum in women is shorter, more concave; and is also broader in proportion to its length. The spaces, vertically, between its foramina in front are very small, forming ridges, which give to the bone the appearance of having been compressed in its length.

The distance between the upper and lower straits, or, in other words, the depth of the small pelvis in women, is not so great as in men: this arises from the comparative shortness in the length of the pubes, of the ischia, and of the sacrum, as just mentioned. The cartilaginous joining of the pubes is thicker in women. The diameters of the inferior strait, like those of the superior, are longer in females.

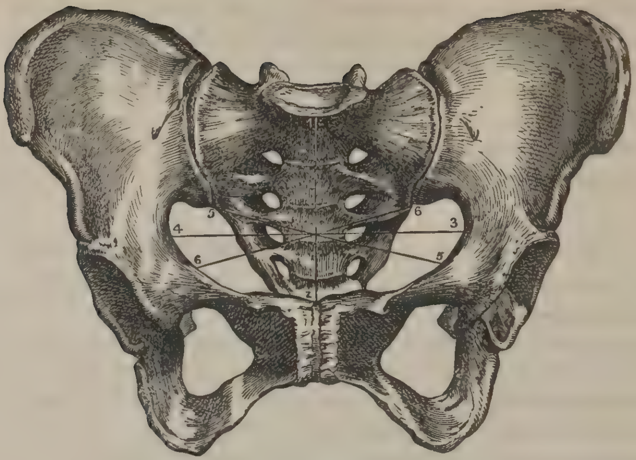
Accoucheurs have attached much importance to the direction and length of the diameters of the small pelvis in well-formed women. At an average they are as follows. The superior strait presents three diameters: the first or antero-posterior extends from the upper extremity of the symphysis pubis to the middle of the projection of the sacrum at its superior margin, and measures four inches: the second diameter, or the transverse, crosses the first at right angles, and extends from the middle of one side of the strait to the corresponding point on the other; it measures five inches: the oblique diameter extends from the sacro-iliac junction of one side to the linea ilio-pectinea behind the acetabulum of the other, and measures four inches and a-half, sometimes more.[1]

At the inferior strait, the antero-posterior diameter is from the lower part of the symphysis pubis to the lower end of the sacrum, and measures five inches.[2] As the coccyx, in child-bearing women, is movable, its projection forwards is not taken into the account, because it recedes by the pressure of the child's head, and does not resist its

[1] See Dewees' System of Midwifery, 7th edition, 1835, p. 28.

[2] Dr. Dewees says four. Loc. cit.

Fig. 29.



An anterior view of the Female Pelvis, showing the shape and diameters of the superior strait. 1, 2. The antero-posterior diameter, measuring 4 inches. 3, 4. The transverse diameter, measuring 5 inches. 5, 5, 6, 6. The two oblique diameters, measuring 4½ inches each.

passage: in some cases, however, it is unfortunately fused into the sacrum, and therefore perfectly rigid, which will diminish this diameter at least an inch. The transverse diameter of the inferior strait is drawn from the middle of the internal margin of the tuberosity of one ischium to the corresponding point on the other, and measures four inches.

The depth of the lesser pelvis, in the female, at the symphysis pubis, is an inch and a-half; at the posterior part four inches, or five if we include the coccyx; and at the side three inches and a half. There are many other details connected with the measurements of the pelvis, which are mentioned by systematic writers on midwifery.

SECT. VI.—DEVELOPMENT OF THE PELVIS.

Three points of ossification are observable in the os innominatum of the early fœtus: one is in the superior portion of the ilium; another is in the tuberosity of the ischium, and the third is near the angle of the pubes. The radii of ossification from these centres have extended themselves considerably at birth, so as to sketch out the forms of the bones to which they respectively belong. But these bones are separated from one another by cartilage, and do not coalesce till years afterwards. The union or fusion of the ilium and pubes then occurs at the ilio-pectineal eminence, over the acetabulum, and partly in this cavity: the ilium and ischium join in the acetabulum principally, and the ischium and pubes unite by their respective crura at the middle of the internal side of the thyroid foramen. All the points of the os innominatum, most remote from the centres of its three pieces, are cartilaginous at birth: as, for example, the crest, the spinous processes,

the tuberosity, and even the component parts of the acetabulum. The latter cavity has then a triangular shape, and from its very flexible and yielding condition, is incapable of affording a strong point of support to the trunk in the erect position.

At birth, the middle parts of the os sacrum, which are employed in protecting the spinal marrow, are more advanced in their ossification than its lateral parts. The five pieces which compose it are, like the bodies of the true vertebræ, of a rounded shape. The processes behind are cartilaginous. The coccyx is extremely small, and scarcely presents any ossification whatever.

The pelvis of the fœtus, at birth, is smaller in proportion than the superior portions of the trunk; this is one of the reasons why the abdomen is so projecting. The lesser pelvis is so small and shallow that the bladder, even in the undistended state, cannot be accommodated by it, but is contained principally by the abdomen. Its transverse diameter is much shorter than the others. The superior strait faces much more forwards than in the adult.

SECT. VII.—ON THE MECHANISM OF THE PELVIS.

The pelvis has an important part in the several actions of standing and of locomotion; besides its usefulness in giving a support to the viscera of the abdomen, and in having attached to, and contained within it, the organs of generation.

In standing, the pelvis is impelled by two opposing forces, in consequence of the attachment of the vertebral column at its hind part, and of the ossa femorum at its anterior lateral parts. The weight of the head and of the upper parts of the body, falling upon the sacrum, acts upon a lever, which is represented by the distance between the acetabula and the sacro-iliac junction, and has a tendency to depress the posterior part of the pelvis, by rotating it upon the heads of the thigh bones. This movement is obviated by the iliacus internus, psoas magnus, and some other muscles, which keep the front of the pelvis from rising up. It is also prevented by the principal weight of the trunk being in front of the spine, and therefore inclining forwards, so that the centre of gravity, in the erect position, gives a continual tendency to fall forwards instead of backwards.

The wedge-like shape of the sacrum is highly favorable to the erect position: from having its base upwards, whenever the weight of the trunk is thrown upon it, it is driven down between the ossa innominata, and has the tightness of its articular connection, therefore, much increased by the position which it is intended to sustain. In illustration of the usefulness of the triangular or wedge-like shape of the sacrum, it may be observed, that it is much less so in animals which are intended to go upon all fours than in the human subject.

The articulation of the several bones of the pelvis with each other is so close as not to admit of any motion between them, with the exception of the os coccygis, and of the relaxation peculiar to pregnancy. The pelvis, however, has upon the spine, flexion, extension, lateral inclination, and rotation; the latter being performed by a series of very

slight twists of the lumbar vertebræ upon each other. Like all other motions, it is much extended by habit in early life. Of this I have seen an instance, in an adult Indian, who, from infancy, had been deprived entirely of the use of the lower extremities; but who, by being seated in a large wooden bowl, with a round bottom, and having his legs drawn up in a squatting position, could, by alternate twists of the spine, with the assistance of a short staff in each hand, move with surprising speed over a plane surface.

SECT. VIII.—OF THE THORAX.

The thorax is the upper part of the trunk, and is formed by the dorsal vertebræ behind, by the sternum in front, and by the ribs with their cartilages at the intermediate spaces. In its periphery it is of a conoidal figure, flattened in front, somewhat bowed behind, and semi-cylindrical on the sides. It is affected in its shape behind, from its symmetrical division into two parts by the ridge of spinous processes of the dorsal vertebræ. On each side of this ridge is a depression called the vertebral gutter, formed by the bridges of the vertebræ, their transverse processes, and by the ribs as far as their angles. This gutter, being narrow at the top, augments both in depth and breadth as it descends to the last rib; the increase of breadth being due to the successively increasing distance of the angles of the ribs from their heads. The interior circumference corresponds with the exterior, with the exception of the posterior part, where, owing to the projection of the column of dorsal vertebræ, a partial septum exists which has a tendency to divide it into two chambers. The superior part of the cone, or its summit, is much smaller than the inferior part or the base, and presents a very oblique cordiform foramen, much lower in front than behind, owing to the superior margin of the sternum being lower than the first dorsal vertebra. The base of the thorax is a very large opening: its lateral and posterior margins, formed by the ribs and their cartilages, present a convexity downwards; but, in front, where the latter run up to join the sternum, a large notch is formed between the cartilages of the opposite sides, into the apex of which notch the third bone of the sternum projects.

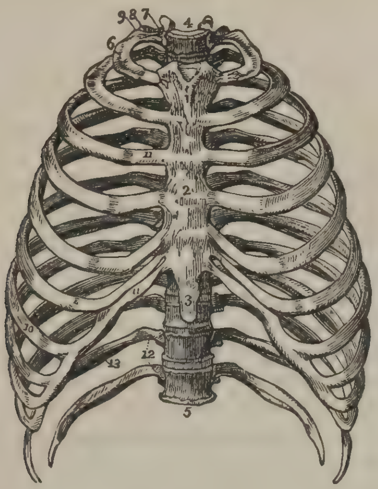
Of the Ribs.

The ribs (*costæ*, *côtes*) are twenty-four in number, twelve on each side. Of the latter, the upper seven, in consequence of their cartilages joining the sternum, are called the sternal or true ribs, and the lower five, from their cartilages stopping short of the sternum, are called the false or a-sternal ribs. Cases are recorded by several anatomists of there being eleven or thirteen ribs on a side: the latter I have seen several times, and the former but once or twice. In such cases, the dorsal vertebræ correspond in number with the ribs. In the instances of redundance which have come under my notice, the last rib looked like a transverse process of unusual length, belonging to a lumbar vertebra. The superabundant vertebra constituted the thirteenth dorsal;

but was formed like the first lumbar as it commonly exists, and the last lumbar vertebra was anomalous in its shape, being intermediate in form to a lumbar vertebra, and to the first bone of the sacrum.[1]

All of the ribs are so placed, that they run very obliquely downwards and forwards from their posterior extremities. This obliquity becomes

Fig. 30.



A front view of the Thorax. 1. First bone of the sternum. 2. Second bone of the sternum. 3. Third bone or ensiform cartilage. 4. First dorsal vertebra. 5. Last or twelfth dorsal vertebra. 6. First rib. 7. Its head. 8. Its neck. 9. Its tubercle. 10. Seventh or last true rib. 11, 11. Costal cartilages. 12. Floating ribs. 13. Groove for the intercostal artery.

the more striking as the ribs increase successively in length. The first rib, for example, articulating by its posterior extremity with the first dorsal vertebra, has its anterior extremity nearly on a horizontal line with the lower part of the third dorsal vertebra. The seventh rib has its anterior extremity on a horizontal line with the lower margin of the last dorsal vertebra, notwithstanding its posterior extremity articulates with the seventh dorsal vertebra. The same sort of comparison may be usefully instituted in regard to all the ribs, in which case the rule will be found closely applicable, with the slight exception of the two or three last ribs. The ribs are nearly parallel to each other in this obliquity, allowance being made for the effect which the obliquity of the sternum has in causing a greater separation of their anterior extremities from each other than exists at their posterior extremities.

Common points of resemblance between the Ribs.—Each rib is paraboloid; presents an external and an internal surface; an upper and a lower margin; a sternal and a vertebral extremity.

The external surface of each rib is convex, while its internal surface is concave. The former presents, not far from the vertebral extremity,

[1] The thirteenth rib is sometimes an appurtenance to the last cervical vertebra, of which I have a specimen, kindly presented by a member of the class in 1848–49, Dr. Walter F. Atlee.

an oblique ridge, occasioned by the insertion of the sacro-lumbalis muscle. It is precisely at this line that a curvature takes place, which is the angle of the rib. Between the angle and the transverse process of the vertebra, each rib is rather more narrow and cylindroid than it is in advance of the angle. The superior margin of the rib is rounded and somewhat rough, for the insertion of the intercostal muscles, while the inferior margin is brought to a thin cutting edge. Just within, and above the latter, is a fossa beginning nearer to the spine than the angle of the rib, and ceasing about one-third of the whole length of the rib, short of its anterior extremity. It contains the intercostal vessels and nerve. From the upper margin of this fossa arises the internal intercostal muscle, and from the lower the external.

The anterior extremities of the ribs are thin and flattened; in the upper eight there is some increase in their breadth at this point, and in all there is an oblong pit for receiving the end of the corresponding cartilage. The vertebral extremity of the rib is its head, and presents two flat articular surfaces, separated by a ridge. This head is received into the inter-vertebral matter, and upon the articular faces of the adjoining margins of two vertebræ. A small depression exists upon the posterior face of the rib bordering on its head, for containing a little fatty mass. About an inch beyond the head, at the posterior under surface of the rib, is a tubercle, presenting a smooth articular face, for connecting itself with the transverse process of the vertebra below. Just beyond this, but bordering on it, is a much smaller tubercle, not unfrequently indistinct, for the insertion of the external transverse ligament, and below it is a small pit for the lodgment also of fatty matter near the joint. The space between the first or greater tubercle and the head of the rib is its neck, which is in contact with the antero-superior face of the transverse process of the vertebra below, and has a sharp ridge on its upper margin, for the insertion of the internal transverse ligament.

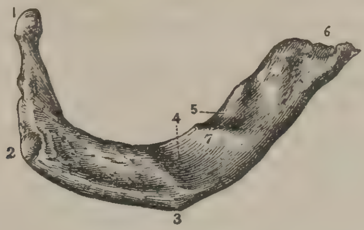
The most of the ribs have a very sensible twist in them, by which their spinal extremity is directed upwards, and the sternal extremity downwards; from which it results that the whole length of the rib cannot be brought into contact with a horizontal plane.

Differences of Ribs.—Though there are many common points of resemblance among the ribs, yet there are, also, some well-marked peculiarities. Thus the ribs increase successively in length from the first to the seventh inclusively; they then decrease by the same rule: the last is not only the smallest, but not unfrequently the shortest. The angles of the ribs increase in their distance from the spine, from the first to the last rib. The angle, however, of the first rib is not well marked, from its being so near the tubercle; nor is the angle of the last, from its being so near the anterior extremity. The oblique ridges constituting or marking off the angles are placed one above the other, in the same line. This gives to the back of the thorax a triangular flatness, the base of which is below. The projection backwards of the angles of the ribs, along with that of the spinous processes of the vertebræ, forms on each side of the latter the vertebral gutter, which

is filled up by the large muscles that keep the trunk erect. This gutter is, of course, broader below.

The first rib is more circular than the others. Its head is hemispherical, instead of presenting two articular surfaces. This rib is flat above and below; its margins are internal and external. It has no groove for the intercostal vessels and nerve. About the middle, the upper surface is marked by a superficial oblique fossa, made by the subclavian artery; in front of, and behind which is a small rising, marking the insertion of the scaleni muscles. The second rib is con-

Fig. 31.



A view of the upper side of the first Rib of the right side, half the size of nature. 1. The head. 2. The tubercle. 3. Anterior surface. 4. Groove for the subclavian artery. 5. Groove for the subclavian vein. 6. Anterior extremity for the cartilage. 7. Tubercle for the scalenus anticus muscle.

siderably longer than the first, and has its flat surfaces obliquely upwards and downwards, so as to round off that part of the thorax. The four inferior ribs decrease at their anterior extremities, or become somewhat tapering. The last two ribs do not articulate with the transverse processes, and consequently, have no corresponding tubercles. As their heads articulate with the middle of the bodies of their respective vertebræ, instead of with the margins, they present only a single and somewhat convex surface. The eleventh rib is marked only for a short distance in its middle by the fossa, for the intercostal vessels. The twelfth rib has no mark of the kind.

There is an augmentation in volume from the second to the eighth rib, inclusively; afterwards they decrease. The angles of the ribs are successively more and more obtuse.

The structure of the rib is spongy, covered with a lamella of compact bone. The spongy structure predominates at the anterior extremity, for there the rib is comparatively soft.

Of the Sternum.

This bone constitutes the middle front part of the thorax, and, owing to the obliquity of the ribs, has its superior end on a horizontal line with the third dorsal, while its inferior extremity is on a horizontal line with the eleventh dorsal vertebra. It is also placed in a slanting direction, so that the lower part recedes from the spine much farther than the upper.

The sternum is oblong, somewhat curved, like a bow, so as to be convex in front, and concave behind. It is divided, in the adult, into three distinct pieces; an upper, middle, and lower, which are held

together by cartilage and by ligament; but not unfrequently in advanced life these pieces are all joined into one by bony union. The first and middle parts join where the second rib is articulated, and the middle and lower where the seventh rib articulates. At these points there is a well-marked transverse ridge, both anteriorly and posteriorly, and between them, on the front of the bone, there are other ridges not so strong indicating the original separation of the bone into several other distinct pieces. These ridges are of a more condensed bony matter and like the epiphyses of the vertebræ. The lateral margins of the sternum are somewhat elevated where the ribs articulate.

The upper end of the sternum is both thicker and broader than the lower end. Where the first and second parts join, there is a narrowing of the two: the same occurs where the second and third pieces unite.

The first or upper bone of the sternum has an irregular square figure; it projects somewhat above, and is slightly hollow below. It is scooped out at the superior margin, and presents a point at each end of the scoop.[1] At the side of the latter is a concave and rounded surface, for articulating with the clavicle; just below which is a rough surface, for the cartilage of the first rib. The bone diminishes much in breadth from this point, and terminates by a narrow oblong face, joining it to the second piece. At each side of this junction both pieces contribute to a fossa for the cartilage of the second rib.

The second bone of the sternum is longer and narrower than the first. At its lower part it increases somewhat in breadth, and then terminates by being rounded off on either side, so that its margins converge towards each other. The sides of this piece afford complete pits for the third, fourth, fifth, and sixth ribs; the pit for the seventh is common to it and the third bone, as the pit for the second rib is common to it and the first bone. The sixth and seventh pits are in contact, the fifth is very near the sixth, the fourth is about half an inch above the fifth. On viewing the whole side of the sternum, it will be observed that the distances between the pits decrease, successively, from the first to the last.

Fig. 32.

A front view of the Sternum. 1. First piece. 2. Second piece. 3. Ensiform cartilage, or third piece. 4. Articular face for the clavicle. 5. Articular face for the first rib. 6. Articular face for the second rib. 7, 8, 9, 10. Articular faces for the last five true ribs.

The third bone of the sternum, in the young adult, is frequently in a great degree or wholly cartilaginous; hence the name of xyphoid cartilage (*cartilago xyphoides* or *ensiformis*) has been applied to it. It is thin, varies remarkably in its breadth in different individuals, and has the lower extremity sometimes turned forwards and sometimes backwards, but most frequently it is inclined only slightly forwards. The base of this piece presents a narrow oblong surface for articulating with the second bone, at each end

[1] At this point in persons somewhat advanced in life there sometimes exist distinct ossifications, one on each side; they are described as Epi-sternal bones, or granules, by Mr. Breschet.

of which is the half fossa for the seventh rib. The margins of the ensiform cartilage are thin, and have the transverse muscles of the abdomen inserted into them. Sometimes the lower extremity, instead of being pointed, is bifurcated.

The sternum is composed of a spongy texture, enveloped by a thin layer of compact substance. Its strength depends, in a great degree, upon its ligamentous covering.

SECT. IX.—OF THE CARTILAGES OF THE RIBS.

These are placed at the anterior extremities of all the ribs, the seven superior of which they unite to the sternum by filling up the space. The length, breadth, and direction of these cartilages are far from being uniform.

The first costal cartilage is short; the following ones increase in length, successively, to the seventh inclusively. The cartilages of the false or abdominal ribs decrease, successively, in length from the eighth to the twelfth, inclusively; the last is a mere tip to the end of the rib. The breadth of the first cartilage is considerable near the sternum; the succeeding ones are not so large at this point. With the exception of the first three, the costal extremities of the cartilages are larger than the sternal; and they become more rounded as they advance to the latter. The cartilages, in point of magnitude, generally, will be found in proportion to the size of the ribs with which they articulate. The sixth and seventh, at their middle, are held together by ligament and spread out, which gives there an increase of breadth, and permits them to touch, and sometimes to coalesce.

The first cartilage goes obliquely downwards in the direction of the rib to which it belongs, in order to join the sternum. The second and the third cartilages are nearly horizontal, but inclining a little upwards in their progress; the fourth, fifth, sixth, and seventh pass successively, more and more upwards to the sternum, in consequence of the increasing length of the ribs requiring them to traverse a longer space to reach this bone. From the direction of the cartilages being obliquely upwards, while that of the ribs is obliquely downwards, the angle formed near the rib at the base of the cartilage, where the latter begins first to turn upwards, is less obtuse in the lower cartilages than in the upper. The obliquity of these cartilages is also very manifest, by comparing them with the side of the sternum: with it they form a very acute angle below, and a very obtuse one above.

The cartilages of the false ribs, as they decrease successively in length, terminate in front by small tapering extremities. The first is united by ligaments, somewhat closely, to the last true or sternal, and is occasionally sent forward fully to the sternum. The others are united more loosely, in such a way that the anterior extremity of the one below lies against the inferior margin of that which is above. The eleventh and twelfth cartilages are generally each too short to touch the one above it; they therefore are fixed principally by a connection

with the abdominal muscles. Their ribs are much more movable than any others, and have been called *floating*, from that cause.

There is some difference between the two extremities of the cartilages; the posterior or costal is a convex, unequal surface, very closely united to the anterior extremity of the corresponding rib. The other or sternal extremity in the sternal cartilages offers a smooth articular face, which is angular or convex, according to the shape of the cavity in the sternum with which it has to articulate. The first three ab-sternal and the last sternal cartilage make, to the lower part of the thorax, a broad and well-marked margin, convex in front and concave behind.

The cartilages of the ribs are, in persons of middle age, white, flexible, and very elastic. They are dissolved very slowly in boiling water; by which they are reduced to gelatin, if young; otherwise their solubility is very imperfect. They have a structure differing, in some respects, from other cartilages; when dried, and exposed to the action of the atmosphere, they are seen to consist of an immense number of small thin plates, placed face to face, and separated by deep fissures. M. Herissant describes these plates as interlaced one with another, and forming a kind of spiral, the regularity of which is interrupted by small cartilaginous projections, uniting the plates to each other.[1] These cartilages have a great disposition to ossify, which is manifested in most individuals somewhat advanced in life. The ossification begins in their centre, and advances to the circumference, and is always preceded by a yellowish tinge. When they are fully ossified, like the ribs, they are cellular within, and compact externally, and are continuous with the ribs, there being no interval: in such cases, the distinction from the sternum is generally kept up by the preservation of the joint, with the exception of the first, which is ossified into it. The complete ossification of the first cartilage is not uncommon; the others, though there is generally in old persons a considerable deposit of bone in them, are seldom fully ossified. In neither case, however, is it common to see such a perfect continuity of bone between the rib and sternum, that the junction may not be dissolved at one point or another of this space by the action of boiling water; at least, after very numerous observations on this subject, I do not remember to have met with a single instance of it.

SECT. X.—OF THE DEVELOPMENT OF THE THORAX.

In the fœtus the shape of the thorax differs much from that of the adult, in the greater comparative extent of its antero-posterior diameter, and in the projection of the sternum. The state of the thoracic viscera, at this period, calls for such an arrangement; as the heart and thymus gland, which are in the middle, have a considerable extent; whereas, the lungs are still collapsed from the emptiness of their air cells. The ribs are but little curved at their posterior parts, the angle being by no means well formed, in consequence of which, the fossa on each side of the bodies of the vertebræ, within the thorax, is not so deep; neither

[1] Acad. des Sciences, an. 1748.

is the fossa behind, on each side of the spinous processes, so fully marked. The superior opening of the thorax is more round from the increase of the antero-posterior diameter. The inferior opening is extremely large, both from the elevation of the sternum, and from the pressure of the abdominal viscera, of which the liver, from its great extent, is a principal agent. The vertical diameter of the thorax is small, from the ribs, particularly the lower ones, being pressed up one against the other, by the diaphragm, acted on by the abdominal viscera.

The bones individually are in the following state at birth. The ribs are almost completed, the heads where they join the spine being in a state nearly as perfect as at any subsequent period of life, and not by any means in the condition of a cartilaginous epiphysis, as is presented in the extremities of the cylindrical bones generally. These bones, as Bichat very justly observes, are destined to a function which commences immediately upon birth, and which requires in them as much perfection then, as they have in the adult. For respiration is different from locomotion; the latter requires a species of education, which may be given gradually, whereas one respires from the beginning as he will respire always. The sternum, which is less immediately connected with breathing, and only contributes to the general solidity of the thorax by completing its circumference, is in a state almost cartilaginous, and presents only nuclei of ossification in its several pieces.

At the instant of birth, a great change is produced in the dimensions of the thorax. The lungs, from being in a collapsed and solid state, suddenly suffer an expansion of their cells by the introduction of air into them, and increase twice or three times in magnitude. This is accomplished by the elevation of the ribs, and the consequent increase in the transverse diameter of the thorax: it becomes a condition that for ever afterwards remains, so that the lungs, even upon death, continue to have their air cells distended, and do not return to a perfectly collapsed state. The action of the diaphragm is but small in the earlier periods of life; owing to the size and pressure of the abdominal viscera against it; respiration is then principally carried on by the elevation and depression of the ribs, and by their being rolled outwards, a motion which the flexibility of their cartilages and the looseness of their articulating surfaces favor very much.

At the age of puberty, the thorax experiences a remarkable augmentation. Its transverse diameter is sensibly increased, and there is a general expansion of its volume, indicative of a healthy and vigorous constitution. Should this not take place, and the sternum be projected, it is supposed to mark a disposition to consumption. The enlargement of the thorax is undoubtedly also connected with a development of the organs of generation at the same time. The exercise of the latter requires greater vital powers than exist in early life, and the provision for it is manifested by the general increase of vigor and firmness in the human frame; but it is not possible to point out in what manner the sympathy exists, which, on the development of the organs of generation, extends their influence to the bony structure of the thorax.

SECT. XI.—OF THE MECHANISM OF THE THORAX.

The thorax performs two very important offices in the animal machine; the first is to contain and protect the organs of circulation and of respiration, the second to assist in the function of respiration and perhaps that of circulation.[1]

The mechanism of the thorax is such that the solidity of its materials, and its rounded shape, present a very efficacious defence of its viscera, from the influence of blows on its outside. The effects of the latter are also materially diminished by the thickness and contraction of the several larger muscles which are placed on its surface. On its back part the thick longitudinal muscles of the spine, as well as those running to the superior extremities, fill up the gutters on each side of the spinous processes, and make a fleshy protuberance, divided into two by the raphe which extends the length of the back over the spinous processes. In front it is less protected, owing to the sternum being immediately under the skin. Nevertheless, when blows are inflicted on this part, their effects are much diminished by the elasticity of the cartilages of the ribs, and by the direction, obliquely downwards, of the ribs themselves; both of which dispose the sternum to retreat backwards, and to yield to the impelling force. The recession will take place more readily at the moment of expiration, and when the muscles which elevate the ribs are not on their guard. In those deliberate exertions of the strength of the thorax, exhibited by individuals lying down on their backs, and sustaining a heavy weight on the sternum, the ribs are saved from injury by different means. The arched form, itself, of the front of the thorax, is of considerable service in the resistance under such circumstances; this, however, would be easily overcome, and the ribs would break, if the arch were not sustained in its elevation by the contraction of the large muscles on its sides, as the serratus major, the pectoralis major and minor, each of which, by acting on the depressed anterior extremities of the ribs and their cartilages, has a tendency to keep them elevated. Fractures of the ribs, from blows or force applied in front, are not so liable to occur in the part stricken as in the point feeling the greatest momentum, which from the semicircular form of the ribs is in or near their middle: this exhibits a true example of what the French writers call the *contre-coup*. Bichat says that the fracture by *contre-coup* is much more common when the individual, being struck unexpectedly, has not had time to throw his muscles into a state of contraction, for the protection of the ribs.

The lateral convexity of the thorax being greater than that in front or behind, and having the same assistance from the muscles mentioned, presents a stronger resistance when blows are inflicted directly on it. Each rib represents an arch, the summit of which is its centre, and the base its two extremities. The abutments of the base are, the sternum at one end and the spine at the other: a displacement from them is completely prevented by the strength of the ligamentous attach-

[1] A very interesting paper on this subject was presented to the French Institute by M. Barry, some years ago.

ments, as well as by the form of the surfaces. Under these circumstances, as fracture occurs preferably to dislocation, it is generally at the point stricken.

The abdominal or false ribs, from their want of attachment to the sternum, present a very different condition. Their anterior extremities, therefore, yield readily, and are driven inwards towards the abdomen.

The second function of the thorax, relating to its influence on respiration, is executed by its dilating and contracting, whereby the air is received into, and expelled from it. The spine is the fixed point for the motions of the ribs in respiration. In the act of dilatation, the capacity of the thorax is augmented in three directions, vertically, transversely, and antero-posteriorly, or from the sternum to the spine. The vertical augmentation is accomplished by the diaphragm; and, as mentioned, is much greater proportionally in the adult than in the infant, from the greater comparative size of the abdominal viscera in the latter. The transverse augmentation is produced by the successive contraction of the intercostal muscles, which raise the ribs upwards. The first rib is moved inconsiderably, in consequence of its shortness and of its continuity with the sternum. The attachment of the scaleni muscles to its upper surface serves rather to give a fixation to it, and to prevent it from being drawn down by the other ribs, than to produce by their contraction an elevation of it. The first rib may, therefore, be considered as a fixed point. The first intercostal muscles contracting from it draw up the second rib, which, in its turn, becoming a fixed point for the second intercostal muscles, they contract and draw up the third rib, and so on successively to the last. It is the obliquity of the ribs from behind, downwards and forwards, which enables this elevation of them to produce an increase in the lateral diameter of the thorax: without such obliquity, their elevation would not have the effect. But the obliquity alone could be of but little service, if the anterior extremities of the ribs were not attached to the sternum by cartilages, which have to ascend in order to reach it; for it is obvious that the angle of the cartilage and rib, during their elevation by the intercostal muscles, has a tendency to enlarge itself; and will, in doing so, increase the horizontal distance between the anterior end of the rib and the sternum, and consequently increase the transverse diameter of the thorax. The upper ribs, from the shortness as well as direction of their cartilages, can do little or nothing in increasing this diameter.

According to some anatomists, the capacity of the thorax is also augmented by a rocking motion of the rib, in which the two extremities being stationary, the middle is drawn upward and outward. It is not, however, very clear that this motion exists to much extent in the adult, as the posterior articulations of the thorax are opposed to it.

While the transverse enlargement of the thorax is going on, a simultaneous motion occurs in the sternum, and in consequence of the oblique direction in which the ribs run to it, the sternum is caused, by the elevation of their bodies, to recede from the spine. But, as the ribs increase successively in length from the first to the seventh, each lower one, in its elevation from the oblique towards the horizontal line, has its anterior extremity carried proportionably farther off from the spine; hence, the sternum has a combined movement resulting from its several

attachments to the ribs: one motion elevates it as a whole, another causes it to recede from the spine as a whole: and the third causes its lower end, from the increased length of the ribs there, to be pushed farther from the spine than the upper; giving it, thereby, during respiration, a slight motion backwards and forwards, resembling that of a pendulum. This latter motion, however, though its existence is clear, is not very considerable, from the sternum being kept in check by the tendinous centre of the diaphragm, as one may prove by examining his own body. The enlargement of the thorax, in its antero-posterior diameter, is much more considerable at the anterior extremities of the ribs, because there, they are comparatively free. In this case, the cartilages of the ribs are bent forwards, besides being elevated.

In expiration, the movements of the thorax are exactly the reverse of what they are in inspiration, and all its diameters are, consequently, diminished. Whatever may be said of muscular influence in producing this change, it is much exaggerated. It is true, that there are certain muscles which may be applied to this end, as the abdominal, and also some on the back, as the longissimi dorsi and sacro-lumbales; but that they are actually so engaged, under ordinary circumstances, is rather questionable. In observing the phenomena of natural respiration, when, by position, all these muscles are put into a state of relaxation, it does not appear that the process is at all impaired by their being thrown out of action. The only muscles, therefore, that seem to be especially appropriated to produce expiration, are few and small: they are the serrati inferiores postici, one on either side of the spine. But, when the lower ribs are fixed by the several muscles inserted into them, they become points of support to the upper ones; and then the intercostal muscles may officiate in expiration, by drawing the ribs successively downwards, as they do in inspiration, by drawing the ribs successively upwards.

The elasticity of the cartilages, by which these bodies are enabled to return from the constrained state in which they were placed by inspiration, has also been supposed important to expiration, by Haller, and others. The power thus derived is certainly of some value; but of much less than has been attached to it. It unquestionably exists in early and middle life, but is lost in old age, when the cartilages ossify, and, therefore, are of diminished elasticity. The true and efficient cause of expiration appears to be atmospheric pressure, upon the external parietes of the thorax, acting along with the natural elasticity of the lungs. The lungs, it is well known, when in a state of repose, and removed from the thorax, are much smaller than the cavities which they fill during life. They have, therefore, a continual disposition, in the living state, to return to the size which is most easy to them; and, when they are dilated by inspiration, they subsequently contract. These positions are proved conclusively by the condition of the inferior surface of the diaphragm in a healthy and entire thorax; where this muscle, in consequence of atmospheric pressure from without, is driven high up into its cavity. Its contraction in inspiration draws it down, and the instant that the contraction ceases, it is impelled upwards again. Now, the same power is applied to the whole periphery of the thorax: and its cavity being enlarged by the contraction of the several muscles

appropriated to the elevation of the ribs, the moment this contraction ceases, the latter are impelled downwards. From all this it will be understood that the muscles, by creating a vacuum in the lungs, cause the vacuum to be filled by the introduction of air through the trachea; and upon their ceasing to contract, the several agents mentioned cause the expulsion of the same air. It is generally believed, that the surface of the lung is everywhere in contact with the thorax; it appears, how ever, doubtful, whether there is not a space between the pleura pulmonalis and diaphragmalis, particularly at the most posterior and inferior part of the diaphragm. Certain it is that adhesions there are much less common than in other parts of the thorax.

The ligaments at the spinal extremities of the ribs, by being put on the stretch in inspiration, have also some tendency to throw down the ribs in expiration. In short, the contraction of the thorax may be set down as the result of the joint action of the atmosphere, the cartilages of the ribs, the ligaments, the contraction of the lungs, and the muscles. When the structure of the lung is so altered that its elasticity is impaired or destroyed, expiration becomes then much more difficult.

CHAPTER II.

OF THE HEAD.

The head is placed upon the upper extremity of the vertebral column, and consists in a considerable number of bones, which are either in pairs, or, if single, have the two sides symmetrical. Some of these bones form a large cavity, the cranium, for containing the brain; the others are employed in the formation of the nose; of the orbit for the eyeball; and of the mouth. The head, for the most part ovoidal, presents very striking varieties of form between different individuals and different nations. It is thought by physiologists that the moral or intellectual condition of a people, their habits, climate, and food, have a powerful influence in producing these diversities. The head is divided into Cranium and Face.

SECT. I.—OF THE CRANIUM.

The Cranium is composed of eight bones: The Os Frontis, the Os Occipitis, two Ossa Parietalia, two Ossa Temporum, the Os Sphenoides, and the Os Ethmoides. The Os Frontis is at the front of the Cranium; the Os Occipitis is at its hind part; the Ossa Parietalia, one on each side, form its superior lateral parts; the Ossa Temporum, also one on each side, form its inferior lateral parietes; the Os Sphenoides is in the middle of its bottom part; and the Os Ethmoides is at the fore part of the centre or body of the last bone.

The cavity thus formed for the brain has three diameters, which may be learned by sawing vertically through the middle line of one

skull, and horizontally through the cavity of another. The first diameter is the longest, and extends from the lower part of the frontal bone to the protuberance on the middle of the interior surface of the os occipitis, or a little above it; it is commonly from six inches and a-half to seven long. The second diameter includes the space between the superior margins of the temporal bones, where they are most distant from each other, and, passing over the middle of the great occipital foramen, is from five inches to five and a-half. The third diameter is taken from the centre of the great occipital foramen to the centre of the suture between the parietal bones; it is also from five inches to five and a-half. Rather more than one-third of the cavity of the cranium is placed behind the second diameter, and it diminishes somewhat abruptly; but in front of this diameter the cavity is finished more gradually.

When the face is separated from the cranium, the exterior surface of the latter, excepting its base, represents somewhat accurately the form and proportion of its cavity: allowance being made for the large sinuses in the lower part of the frontal bone, and for the thinness of the upper parts of the temporal bones. The diameters mentioned can only represent what most frequently happens, for daily observation proves remarkable departures from them. Sometimes the transverse diameter is increased at the expense of the longest, which gives to the cranium a flatness before and behind. On other occasions, the vertical diameter is increased, and the others reduced, whereby the cranium receives a conical form. In many individuals the first diameter is increased, which makes the two sides of the cranium more parallel and flat than usual. The elongation of the transverse diameter is the most common, and that of the vertical the least so. The capaciousness of the cranium is much the same in adult individuals of the same sex; from which it may be inferred that the excess of one diameter is obtained generally at the expense of the other. The male cranium is more capacious and thick than the female.

The female sex is less liable to variations in these proportionate diameters than the male. Stature has but little influence on the capaciousness of the cranium, as giants and dwarfs have it of the same size; hence, the former seem to have very small heads, while the latter appear to have very large ones, the eye being deceived by the relative magnitude of their bodies.

The fact seems to be now well ascertained, that continued pressure, or rather, resistance in a fixed direction, made upon the cranium of a growing infant will change its natural form. Peculiar ideas of beauty have induced certain tribes of savages to adopt this barbarous and unnatural practice. The late Professor Wistar[1] showed to his class, in 1796, a Choctaw Indian having this peculiarity; and a tribe now existing near the sources of the Missouri continues the practice of flattening both the occiput and the os frontis.

In the Wistar Museum we have ten heads[2] of Peruvian Indians, brought from the Pacific Ocean, nine of which bear the strongest evidence of having been flattened by pressure, on the os frontis and on

[1] System of Anat. 3d edit. vol. i. p. 73. 1824.

[2] Presented by Dr. James Corneck, U. S. Navy, to the late Dr. Physick.

the os occipitis.[1] The possibility of effecting such a change in the form of the cranium has been strongly contested; and Bichat, who admits it, acknowledges that he was unable to produce like modifications in puppies, kittens, and India pigs. The singular change, however, which is wrought upon the feet of Chinese ladies strongly corroborates the opinion of the head being also susceptible of artificial modification in its form.[2]

SECT. II.—OF THE INDIVIDUAL BONES OF THE CRANIUM.

1. *Frontal Bone* (*Os Frontis, Frontal*).

The frontal bone forms the whole anterior, and a portion of the superior, lateral, and inferior parietes of the cranium. It is symmetrical, and, occasionally, is completely divided into two pieces by the continuation of the suture between the parietal bones.

Its external face is convex, and the internal concave. On the former may be observed a line, or slightly raised ridge, running on the middle of the bone from above downwards, which is expressive of the original separation between its two halves. The front surface of the bone is terminated on either side, below, by the orbitary or superciliary ridge, a sharp and arched elevation, forming the upper anterior boundary to the orbit of the eye. This ridge terminates outwardly by the external angular process, which is joined to the malar bone; and inwardly by the internal angular process. Just above the internal half of the orbitary ridge the bone is raised, by the separation of its tables, into the superciliary or nasal protuberance or boss. Between the internal

[1] The following letter, from a distinguished Missionary, the Rev. Mr. De Smet, S. J., who had spent some years among the Indians, on the west side of the Rocky Mountains, will be read with interest:—

To Professor William E. Horner, M. D.

The process of flattening the head exists among several tribes on the Columbia River. Among the Indians at the cascades, and Tchenouks at Fort Van Couver, I remarked several babes, who were undergoing the barbarous process. They attach them to boards of about two feet in length. This sort of cradle is covered with a skin, with the hair outside; the child is stretched on it; its little arms are tied close to the body with soft leather bandages; another skin is fastened to each extremity of the board and covers the child. A smooth strip of cedar bark, or of other elastic wood, four or five inches broad, is fastened over the forehead of the babe, so tight, that the eyes of the infant appear to start from their very sockets. In this painful situation, I was told, they have them for the space of about a year, after which the head has taken the form they wish to give it, and which they consider as a mark of distinction and of great beauty. This deformity in children is very apparent; the forehead and the upper part of the head are in a straight line. The deformity disappears partly as they grow old. These Indians have slaves, who are forbidden, under the severest penalty, to flatten the heads of their offspring. The cascade Indians and Tchenouks are remarkable for their ingenuity in constructing convenient and beautiful canoes, nets, and wooden utensils; they are in no ways considered inferior to their round head neighbors. Their constant intercourse with the whites has rendered them more vicious, poor and indolent; they are much addicted to lying, stealing and immorality.

P. I. DE SMET.

Philadelphia, *February 10th*, 1843.

[2] In an examination the author made of an adult female of this nation, Among Foy, the measurements were two inches and one-eighth from the heel to the end of the small toe; four inches and three-quarters from the heel to the end of the great toe; and the circumference of the ankle six inches and six-tenths.

angular processes a broad serrated surface exists, by which the frontal bone is united to the nasal bones, and to the nasal processes of the superior maxillary bones. The centre of this surface is elevated into the *nasal spine*, which serves as an abutment to the nasal bones, and resists any force which might tend to drive them inwards. On its exterior lateral surface, behind the external angular process, the frontal bone presents a concavity bounded above by a well-marked semicircular ridge, the temporal or parietal, and intended for the lodgment of a part of the temporal muscle.

On each side of the front of the bone, near its middle, a prominence exists, most frequently better marked in infancy than in advanced life, and called by the French the frontal protuberance, it being the original centre of ossification for that side of the bone.

Proceeding backwards from the inferior part of the bone are the two orbitar plates or processes, concave below and convex above. They are

Fig. 33.

A view of the lower part of the Os Frontis. 1. Line of junction of the two halves of the bone. 2. Frontal protuberances. 3. Supra-orbitar notch. 4. Nasal spine, and space filled by the ethmoid bone. 5. Frontal sinuses. 6. Orbitar plates. 7. External angular process; the depression for the lachrymal gland is seen in the dark surface just within the line of reference. 8. Surface for the temporal muscle.

much thinner than other parts of the bone, and are separated by an oblong opening which receives the ethmoidal bone. A depression large enough to receive the end of a finger is at the exterior anterior part of the orbitar process, being protected by the external angular process; this depression contains the lachrymal gland. Half an inch above the lower margin of the internal angular process, a much smaller depression exists, occasioned by the tendon of the superior oblique muscle, where it plays upon its trochlea. In the orbitary ridge, just without the latter depression, is the supra-orbitar foramen or notch, for the passage of the supra-orbitar artery and nerve.

The internal margins of the orbitar processes are broad and cellular where they join the ethmoid bone; and at their fore part is seen a large opening on each side leading into the frontal sinus. These margins, in common with the ethmoid bone, form two foramina, one anterior, another posterior, and called internal orbitary or ethmoidal; the first transmits the internal nasal branch of the ophthalmic nerve and the anterior ethmoidal artery and vein; the latter transmits the posterior ethmoidal artery and vein. Externally and behind, the orbitar process

presents a broad triangular serrated surface for articulating with the sphenoid bone.

The interior or cerebral face of the os frontis is strongly marked by depressions corresponding with the convolutions of the brain; and on its middle exists a vertical ridge, becoming more elevated as it approaches the ethmoidal bone. This ridge, the frontal crest (*Crista Frontalis interna*), is situated below, extends about one-half of the length of the bone, and terminates, above, in a superficial fossa, made by the longitudinal sinus of the dura mater; at its lower extremity is the foramen cæcum, common to it and the ethmoid bone, and which is occupied by a process from the great falx of the dura mater, and also affords passage to some very small veins, which go from the nostrils to the commencement of the longitudinal sinus.[1]

The frontal sinuses consist in one or more large cells, placed beneath the nasal protuberances. There is a very great variety in their magnitude and extent; sometimes they proceed as far outwards as the external angular process, and backwards for half an inch into the orbitar plates. In a few instances in the adult they do not exist, but the cases are very uncommon. The cells of the opposite sides have a complete partition. They communicate with the cavity of the nose through the anterior ethmoidal cells.

With the exception of the inferior part, where the processes and sinuses exist, the os frontis is of a very uniform thickness, and the diploic or cellular structure is found constantly between its external and internal faces.

This bone is united to the parietal, ethmoidal, and sphenoidal of the cranium; and to several bones of the face.

2. *Parietal Bones* (*Ossa Parietalia, Os Parietaux*).

These bones, it has been stated, form the superior and lateral parts of the middle of the cranium. They are quadrilateral, convex externally, and concave internally. Their external and internal tables are separated by a diploic structure, which, from being more abundant at the superior half of the bone, occasions there an increased thickness.

The external surface of the parietal bone is raised about its middle into the parietal protuberance. Just below this protuberance is an arched, rough, broad, but slightly elevated surface, the parietal ridge, marking the origin of the temporal fascia and muscle, and continuous with the ridge on the side of the frontal bone. The internal surface of the bone is marked by the convolutions of the brain; there is also a number of furrows upon it, having an arborescent arrangement, and produced by the ramifications of the middle artery of the dura mater. The furrows all proceed from two larger ones at the inferior part of the bone. Of the two furrows, the foremost may be traced from the greater wing of the sphenoidal bone, and runs near to and nearly parallel with the anterior margin of the parietal, being not unfrequently at the latter

[1] Portal, Anat. Médicale.

point converted into a perfect tube by the deposition of bone all around the artery; the other furrow, passing from the squamous portion of the temporal, is commonly a little behind the middle of the parietal bone, and inclines towards its posterior superior angle; the general course of the branches of these furrows is upwards and backwards. The internal face of the parietal bone also presents an imperfect fossa at its superior margin, which is completed by junction with its fellow, and accommodates the longitudinal sinus of the dura mater. Near this edge it is not uncommon to see one or more small irregular pits passing through the internal table, and looking somewhat ulcerated: these are formed by the glands of Pacchioni, in the dura mater. At the inferior posterior corner of the bone, there is also a fossa, which is made by the lateral sinus of the dura mater.

The superior, the posterior, and the anterior margins of the parietal bone are regularly serrated, and nearly straight. The inferior margin is concave, presenting a thin, bevelled, radiated surface before, for articulating with the squamous portion of the temporal bone: behind this concavity, the angle of the bone is truncated and serrated, for articulating with the angular portion of the os temporis. The anterior inferior angle is the most remarkable, from its being elongated so as to join the sphenoid bone in the temporal fossa.

A foramen, called parietal, is found at the superior margin of this bone, nearer to its posterior than to the anterior edge; it transmits an artery between the integuments and dura mater, and also a vein from the integuments to the longitudinal sinus. M. Portal says, that in some protracted headaches this vein swells considerably; and that he has seen much good in such cases arise from the application of leeches to the part: he has also seen, in a child, its tumefaction the precursor of the paroxysms of epilepsy.

The parietal bone articulates with its fellow, with the frontal, the sphenoid, the temporal, and the occipital bones.

3. *Occipital Bone* (*Os Occipitis, Occipital*).

This bone is quadrilateral, and resembles a trapezium. It is convex externally, and concave internally; but both of these surfaces are much modified by ridges and processes. Its thickness is also very unequal; though, like the other bones, it has two tables, with an intermediate diploë. It is so placed as to form a considerable share of the posterior and inferior parietes of the cranium.

The foramen magnum is found in the lower half of this bone, and constitutes a very conspicuous feature in it. This hole is oval, the long diameter extending from before backwards. Its anterior inferior margin, on either side, is furnished with a condyle for articulating with the first vertebra of the neck. These condyles are long eminences tipped with cartilage, which converge forwards, so that lines drawn through their length would meet an inch in front of the foramen magnum; they recede behind; their internal margins are deeper than their external.

The condition of their articular surfaces is, therefore, such that they permit flexion and extension of the head, but not rotation. The anterior edge of the foramen is thicker than the posterior. This foramen is occupied by, or transmits the medulla oblongata, the vertebral arteries and veins, and the spinal accessory nerves.

The external surface of the occiput presents, half way between the foramen magnum and the upper angle of the bone, the external occipital protuberance (*Spina externa*), from the lower part of which a small vertical ridge, the occipital crest (*Crista externa occipitalis*), is extended in the middle line to that foramen. Into the ridge is inserted the Ligamentum Nuchæ. From either side of the protuberance an arched ridge is extended to the lateral angle of the bone; it is the superior semi-circular ridge or line from which arise the occipito-frontalis and the trapezius muscles, and into it is inserted a part of the sterno-cleido-mastoideus. Below this, about an inch, is the inferior semicircular ridge, more protuberant, but not so distinctly marked in its whole course. Into the inner space, between the upper and lower ridges, is inserted the complexus muscle, and into the outer space between the same the splenius muscle. The lower ridge is principally occupied by the insertion of the superior oblique muscle of the neck.

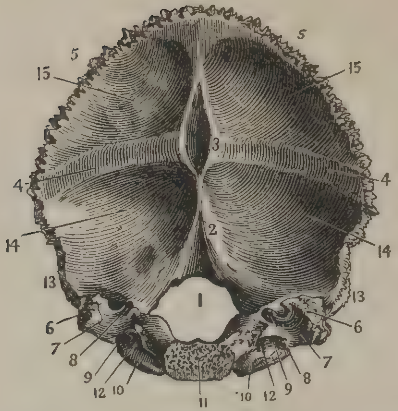
The inner space between this ridge and the great foramen gives insertion to the rectus posticus minor, and the outer space affords insertion to the rectus posticus major. Into a small elevation, leading from the outside of the condyle directly to the margin of the bone, is inserted the rectus capitis lateralis.

In a depression behind each condyle is the posterior condyloid foramen, which conducts a cervical vein to the lateral sinus. Passing through the base of the condyle, and having its orifice in front, is the anterior condyloid foramen, for conducting the hypoglossal nerve to the tongue.

That part of the bone before the condyles is the cuneiform or basilar process; the base of which is marked by depressions for the insertion of the recti muscles, which are situated on the front of the cervical vertebræ; and its fore part, which is truncated at the end, overhangs the pharynx, and is placed against the body of the sphenoid bone. The superior external part of the os occipitis is uniformly convex, being covered by the occipito-frontalis.

The internal surface of the os occipitis is strongly impressed by ridges and depressions. On that portion of it behind the great foramen, is a rectangular cross, forming at its centre the internal occipital protuberance (*Spina interna*), which is much larger than the external. The upper limb of the cross is marked by a fossa for the posterior end of the longitudinal sinus; the two horizontal limbs are also marked, each by its respective fossa, which receives the corresponding lateral sinus. The right fossa is frequently the largest. The inferior vertical limb of the cross (*Crista interna*) has attached to it the small falx of the dura mater, and is slightly depressed by a small sinus. The spaces between the limbs of the cross are much thinner than other parts of the bone, and present broad concavities, the two superior of which

Fig. 34.



The internal surface of the Occipital Bone.—1. Foramen magnum. 2. Ridge for the falx minor, and depression for a small sinus. 3. Internal occipital protuberance, and the depression strongly marked in this bone for the torcular Hierophyli. 4, 4. Lateral limbs of the occipital cross, and depression for the lateral sinus. 5. Margin for the parietal bone. 6. Jugular eminence. 7. Jugular fossa, for the transmission of the jugular vein, and the eighth pair of nerves. 8. Internal orifice of the posterior condyloid foramen. 9. Margin for the petrous portion of the temporal bone. 10. The condyles. 11. The surface for the sphenoid bone; or, the anterior extremity of the basilar process 12. Exterior edge of the basilar process. 13. Margin for the mastoid portion of the temporal bone. 14. Depression for the cerebellum. 15. Depression for the posterior lobes of the cerebrum.

(the fossæ cerebri) receive the posterior lobes of the cerebrum, and the two inferior (the fossæ cerebelli) the lobes of the cerebellum.

The superior face of the cuneiform process is excavated, longitudinally, by the fossa basilaris, to receive the medulla oblongata. On each side of the foramen magnum, a short curved fossa is observed, which receives the inferior end of the lateral sinus of the dura mater, just before its exit from the cranium.

The two superior margins of the occipital bone are regularly serrated. The inferior margins have each, in their centre, a process termed the jugular eminence, in front of which is a rounded notch (*Incisura jugularis*), forming a part of the jugular fossa; this notch is continuous with the semicircular fossa which holds the inferior end of the lateral sinus, and transmits the internal jugular vein and eighth pair of nerves. The edge of the bone above this eminence is serrated, but below it is rather smooth and rounded, being parallel with the temporal bone, and having an imperfect adhesion to the petrous part of it, before the jugular fossa.

The occipital bone articulates above with the parietal; laterally with the temporal, and in front with the sphenoidal.

4. *Temporal Bones* (*Ossa Temporum*, *Temporaux*).

These bones form portions of the inferior lateral parietes, and of the base of the cranium.

Their figure is very irregular. Their circular anterior portion is called squamous: behind it, is the mastoid, and between the others is the petrous.

The squamous portion is thinner than the other bones of the cranium

that have been described; but the temporal muscle and fascia cover it, so as to contribute to the protection of the brain. Its exterior surface is smooth and slightly convex. The interior is formed into depressions by the convolutions of the brain. At the anterior inferior part of the latter surface, a groove is made by the middle artery of the dura mater, immediately after it gets from the foramen spinale of the sphenoid bone on its way to the parietal. This groove bifurcates; one branch runs backwards to join the posterior groove of the parietal bone, and the other ascends to join the anterior groove of the same, frequently, however, impressing the top of the great wing of the sphenoid, just before it reaches the parietal. The greater part of the circumference of this portion is sloped to a sharp edge, but at the anterior inferior part it is serrated and thicker. On the outside of the latter, is the glenoid cavity, for articulating with the lower jaw: the length of it is transverse, with a slight inclination backwards and inwards, so that a line drawn through it would strike the anterior margin of the foramen magnum occipitis. The anterior margin of this cavity is formed by a tubercle, on which the condyle of the lower jaw rises when the mouth is widely opened. The outer margin of the glenoid cavity is formed by the root of the zygomatic process. The zygomatic process has a broad horizontal root, from which it extends outwardly, and then diminishing, runs forward to join the malar bone. Posterior to the root of the zygomatic process, a small ascending groove may be occasionally seen, made by the middle temporal artery.

The mastoid portion of the temporal bone is thick and cellular. Its upper part forms an angle, which is received between the parietal and occipital bones: both margins of this angle are serrated. Below, is the mastoid process, a large conical projection eight lines long, into which are inserted the sterno-mastoid and trachelo-mastoid muscles. At the inner side of its base is a fossa affording origin to the digastric muscle. The inner face of the mastoid portion is marked by a deep large fossa for the lateral sinus of the dura mater. In the posterior part of the suture, uniting the mastoid portion and the occipital bone, or in the former near the suture, is the mastoid foramen, for conducting a vein from the integuments into the lateral sinus.

The cells in the mastoid portion are large and numerous, and obtain the name of sinuses; they communicate with the tympanum by one large orifice. On the outer side of these sinuses a thin diploic structure is observable in some heads.

The petrous portion of the temporal bone is a triangular pyramid, arising by a broad base from the inner side of the mastoid and squamous portions. It is fixed obliquely forwards, between the sphenoid and occipital bones. Its anterior surface is marked by the convolutions of the brain. Near the centre of this surface, and having a little superficial furrow leading to it, is a small foramen called the hiatus Fallopii, through which passes the Vidian nerve. The posterior surface of the petrous portion presents a large foramen, the meatus auditorius internus, through which pass the seventh or the auditory and the facial nerve. Half an inch behind this orifice, is a very small one, overhung

by a flat shelf of bone; this is called the aqueduct of the vestibule. Just above the meatus auditorius internus is a foramen more patulous than the aqueduct, for transmitting small blood-vessels.

In the base of the petrous portion, between the mastoid and zygomatic processes, is the meatus auditorius externus, a large opening conducting to the tympanum. It is oval, about half an inch deep, and varies much in its size in different subjects: its margin is called the auditory process, the lower part of which is very rough, for attaching the cartilage of the external ear.

The lower surface of the petrous bone is exceedingly irregular. Immediately below the meatus auditorius externus, is the *parotid* de-

Fig. 35.

The internal surface of the Left Temporal Bone. 1. Squamous portion. 2. Mastoid portion. 3. Petrous portion. 4. Groove for the posterior branch of the middle artery of the dura mater. 5. Bevelled edge of the squamous portion. 6. Zygomatic process. 7. Digastric fossa. 8 Occipital margin. 9. Groove for the lateral sinus. 10. Position of the superior petrous sinus. 11. Opening of the carotid canal. 12 Meatus auditorius internus. 13. Supposed aqueduct of the vestibule. 14. Styloid process. 15. Stylo-mastoid foramen. 16. Carotid foramen. 17. Spine separating the eighth pair of nerves from the jugular vein. The dark depression immediately in advance of the number, is the opening of the aqueduct of the cochlea. 18. Points to the Vidian foramen, on the anterior surface of the petrous portion. 19. Origin of the levator palati and tensor tympani muscles.

pression which seems like a part of the glenoid cavity, but is not, inasmuch as it does not form a portion of the articular surface for the lower jaw, but simply allows room for its motions, the parts which it contains (consisting of vessels, and a portion of the parotid gland) being pressed back when the jaw opens. Between this cavity and the glenoid is the glenoidal fissure (*Fissura Glasseri*), separating the petrous from the squamous bone. In this fissure is a foramen, which, leading to the tympanum, contains the processus gracilis of the malleus with its muscle, and the chorda tympani. The posterior margin of the *parotid* depression in the petrous bone is made by a long rough ridge, called processus vaginalis; just behind which, and partially surrounded by it, is the styloid process. The styloid process is round, tapering, and an inch and a half long; but frequently absent in prepared skulls, from accidental fracture and from being in a cartilaginous state. From it the styloid muscles arise.

Behind the root of the styloid process, is the stylo-mastoid foramen, which transmits the portio dura or facial nerve to the face. Just

within the styloid process and this foramen is a deep depression, called jugular fossa, large enough to receive the tip of the little finger. The fossa, along with the corresponding one in the os occipitis, is occupied by the internal jugular vein and the eighth pair of nerves. Immediately before the lower end of this fossa is the foramen caroticum, being the lower orifice of a crooked canal, which terminates at the apex of the petrous bone, and transmits the carotid artery and the upper part of the sympathetic nerve. At the inner side of the carotid canal, a superficially serrated surface is perceived, which receives the adjoining edge of the basilar process of the occipital bone. Just in advance of the inner part of the jugular fossa is a small spine of bone, at the foot of which is a pit, containing the orifice of the aqueduct of the cochlea. This spine separates the eighth pair of nerves from the internal jugular vein.

In the angle between the squamous and petrous parts, within the glenoid fissure, is the orifice of the Eustachian tube. The tube is divided longitudinally by a bony partition. The upper division contains the tensor tympani muscle.

A small groove exists along the superior angle of the petrous bone; and another along the inferior angle, adjoining the basilar process of the occipital bone, and formed in part by it: they are made by the superior and the inferior petrous sinuses.

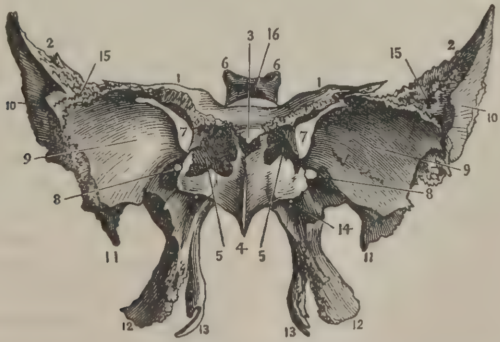
The temporal bone articulates with the occipital, the parietal, the sphenoid, and the malar.

5. *Sphenoid Bone* (*Os Sphenoides*, *Sphénoide*).

The sphenoid is a symmetrical, but very irregular bone, placed transversely in the middle of the base of the cranium.

It consists of a cuboidal body in the centre; of a very large process called the great wing, spreading laterally to a considerable distance on either side of the body; and it has, also, a number of angular margins and additional processes about it.

Fig. 36.



The anterior and inferior surface of the Sphenoid Bone. 1, 1. Apophyses of Ingrassias. 2, 2. The great wings. 3. Crista sphenoidalis. 4. Azygous process. 5. Sphenoidal cells, after the abolition of the pyramids of Wistar. 6. Posterior clinoid process. 7. Sphenoidal foramen. 8. Foramen rotundum. 9. Orbital face. 10. Surface for the temporal muscle. 11. Styloid process. 12. External pterygoid process. 13. Internal pterygoid process. 14. Pterygoid foramen. 15. Articular surface for the os frontis. 16. Points to the sella turcica.

In regard to the body of the sphenoid bone, from its upper anterior part arise, one on each side, the apophyses of Ingrassias, or the little wings. These wings have a broad horizontal base, and extending themselves outwardly, terminate in a sharp point. Their anterior edge is serrated for articulating with the os frontis; the posterior edge is smooth. Between these two wings, in front, is a prominence united to the ethmoid bone. The base of the wing is perforated by the foramen opticum, for transmitting the optic nerve with the ophthalmic artery. Below and behind this foramen, the little wing terminates in a point, called the anterior clinoid process. Between the foramina optica is a ridge of bone, sometimes called processus olivaris, and just above the ridge a groove, made by the optic nerves where they unite. Behind the ridge is a depression, the Sella Turcica, for containing the pituitary gland. This depression is bounded behind by a very elevated transverse ridge, called the posterior clinoid process, on the posterior face of which again is a well-marked acclivity called the *Clivus*, upon which touches the Pons Varolii. At either extremity of the base of the clivus, a groove (*sulcus caroticus*) is made by the carotid artery, which groove may be traced indistinctly by the side of the sella turcica and under the anterior clinoid process, where it forms a notch, and sometimes a foramen.

The posterior face of the body of the sphenoid bone presents a flat surface for articulating with the cuneiform process of the occipital. In the adult, these bones are consolidated at this junction. The inferior part of the body of the sphenoid presents a rising in its middle called the sphenoidal or azygous process (*Rostrum sphenoidale*), being for articulation with the vomer; this process is continued forward to the top of the bone as a sharp ridge (*Crista sphenoidalis*), which joins with the nasal septum of the ethmoid. On each side of this process, in front, is the orifice of the sphenoidal cells. These cells consist, most commonly, of one on each side, and are separated by a bony partition. In the very young bone they are not formed. The body of the sphenoid undergoes so many changes, between early infancy and adult life, by the conversion of its diploic structure into sinuses or cells, and is also so much modified in different individuals, that a general description of it will not answer for all specimens.

The two great wings arise from the sides of the body of the sphenoid by a small irregular base. From their lower part project downwards, on either side, the two pterygoid processes called external and internal. These processes have a common base, are partially separated behind by a groove called pterygoid fossa, and below by a notch (*incisura pterygoidea*). The internal (*ala interna*) is the longer, and is terminated by a hook, on the outer side of which is a trochlea made by the tendon of the circumflexus palati muscle. The external pterygoid process (*ala externa*) is the broader. By applying together the temporal and sphenoid bones, a groove, common to the two, leading to the Eustachian tube, will be seen. This groove is continued obliquely across the root of the internal pterygoid process, and indicates the course and surface of attachment of the cartilaginous portion of the Eustachian tube. The internal pterygoid process sends out from its base a small shelf of bone separated by a fissure from the under part

of the body of the sphenoid. The posterior edge of the vomer rests against this projection. The fissure is filled up in advanced life.

The great wings of the sphenoid bone present three faces. One is anterior, and called orbital from its forming a part of the orbit; another is external, and called temporal; and the third is towards the brain, and forms a considerable part of the fossa for containing its middle lobe. The orbital face is square and slightly concave. The temporal face is an oblong concavity, at the lower part of which is a triangular process, giving an origin to the external pterygoid muscle. The cerebral face is concave and marked by the convolutions of the brain, as well as by a furrow above, made by the anterior branch of the great artery of the dura mater, as it passes from the temporal bone to the temporal angle of the parietal. The inferior portion of the great wing is elongated backwards into a horizontal angle, called the spinous process, which is fixed between the petrous and squamous portions of the temporal bone. From the point of the spinous process, projects downwards the styloid process. The great wing presents a triangular serrated surface above, at its outer end, by which it articulates with the os frontis; just below this, in front, is a short serrated edge, by which it articulates with the malar bone. The tip of the large wing generally articulates with the parietal bone, but in some cases the parietal does not come that far forward; and externally is a semicircular serrated edge by which the great wing articulates with the squamous portion of the temporal bone.

Between the apophyses of Ingrassias and the greater wings is the foramen sphenoidale, called also foramen lacerum superius of the orbit. It is broad near the body of the bone, and becomes a mere slit at the extremity of the little wing. Through it pass the third, the fourth, the first branch of the fifth, and the sixth pair of nerves. Two lines below the base of this hole is the foramen rotundum, for transmitting the second branch of the fifth pair of nerves. Eight lines, or thereabouts, behind the foramen rotundum is the foramen ovale, for transmitting the third branch of the fifth pair of nerves. Two lines behind the foramen ovale is the foramen spinale, for transmitting the middle artery of the dura mater. In the under part of the bone, and passing through the root of the pterygoid processes, is the foramen pterygoideum, also called the Vidian canal, for transmitting the pterygoid nerve; it being a recurrent branch of the second branch of the fifth pair of nerves. Along the posterior border of the spinous process and the external pterygoid is a notch, subtended by ligament, sometimes a perfect foramen of large size; it is the foramen pterygo-spinosum (seu *interruptum*) of Fäsebeck, and transmits a nervous filament to the ganglion oticum.

The sphenoid[1] bone articulates above and in front with the vomer, the frontal, ethmoidal, malar, and parietal bones; laterally with the temporal; behind with the occipital, and by its pterygoid processes with the palate bones.

[1] This bone is, by some anatomists, described in common with the os occipitis, as the *os basilare*, or foundation bone, in consequence of their early junction into a single piece.

The Pieces of the Cranium are considered, by some naturalists, as equivalent to three vertebræ; the first is one formed by the occiput; the second by the sphenoidal bone, the temporal and the two ossa parietalia; and the third by the sphenoid, frontal and ethmoid. In the sheep, dog, and in the pig, this analogy is more evident than in the human subject.

An occipital bone, being the first cranial vertebra, exhibits all the elements of a vertebra, as follows: the foramen magnum corresponds with the spinal canal; the basilar process is the body of a vertebra; the condyles the articulating processes; the portion exterior and lateral to them, or the jugular eminences, are the transverse processes, and the back part of the bone is the vertebral arch and spinous process.

The second cranial vertebra is formed as follows: the parietal, the squamous, and the great wings of the sphenoid, correspond with the arch of a vertebra. The body of the sphenoid is the body of a vertebra modified, while the glenoid cavities and the mastoid processes correspond with the articular and transverse processes.

The front of the body of the sphenoidal, and the ethmoidal make the body of the third cranial vertebra, and the os frontis its remaining portions.

This analogy, first indicated by Dumeril, was still further explained by Geoffroy St. Hilaire. These pieces have been called Cranial Zones by Cuvier,[1] which is a less forced expression than the other, and explains well the simple fact of their ring-like condition. In following out this idea, it would not be a bad substitution of terms to call the cranial pieces the cerebral zones, and the pieces of the vertebral column the spinal zones, from their surrounding the spinal marrow: in each case, the pieces having been modified, so as to suit the especial circumstances of contents, muscular attachment, and support. The term vertebra, derived from the function of turning, is inapplicable to many of the pieces of the spine in the human subject, whereas zone or ring is everywhere appropriate.

6. *Ethmoid Bone* (*Os Ethmoides*, *Ethmoide*).

This bone is placed between the orbitar processes of the os frontis, and, as has been stated, fills the space between them. It is cuboidal, extremely cellular, and light.

The horizontal portion between the orbitar processes is the cribriform plate (*Lamina cribrosa*), called so from its numerous perforations. This is divided, longitudinally, above and below, by a vertical process or plate; and from the under surface on each side, is suspended the cellular or lateral portion (*Labyrinthus*).

The vertical process, as placed on the superior face of the cribriform plate, is the crista galli, which extends sometimes from the back to the front of this plate, and is thickest in the middle. The commencement of the great falx arises from it, and occasionally it contains a cell or sinus, opening into the nose. Between the front of the crista galli and the os frontis, is the foramen cæcum, already described. On either side of the crista galli, the cribriform plate is depressed into a gutter for

[1] See Règne Animal, tom. i.

holding the bulb of the olfactory nerve, and is perforated with many holes for transmitting its ramifications. The anterior foramen on each side is oval, and transmits to the nose the internal nasal nerve, after it has got into the cranium through the anterior internal orbitar foramen.[1] The margins of the cribriform plate show many imperfect

Fig. 37.

The Ethmoid Bone seen from above and behind. 1. The nasal lamella. 2, 2. The cellular portions; the numbers are placed on the posterior border of the lateral part of each side. 3. The crista galli. 4. The cribriform plate of the left side, pierced by its foramina. 5. The hollow space immediately above and to the left of this number is the superior meatus. 6. The superior turbinated bone. 7. The middle turbinated bone; the numbers 5, 6, 7 are situated upon the internal surface of the left lateral portion, near its posterior part. 8. The external surface of the lateral part, or os planum. 9. The superior or frontal border of the lateral part, marked by the anterior and posterior ethmoidal cells. 10. Refers to the concavity of the middle turbinated bone, which is the upper boundary of the middle meatus of the nose.

cells, which are completed by joining their congeners in the margins of the orbitar processes of the os frontis.

The vertical process, as placed below the cribriform plate, is called nasal lamella. It generally divides the nostrils equally, but is occasionally inclined to one side. It joins below, to the vomer and the cartilaginous septum of the nose; its front is in contact with the nasal spine of the frontal bone, and with the nasal bones; and behind, with the azygous process, or rather the crista of the sphenoid.

Each cellular portion of the ethmoid forms, by its exterior, a part of the orbit of the eye, which surface is called os planum, or *lamina papyracea.* The internal or nasal face forms part of the nostril. The fore part of this face is flat, but, posteriorly, in its middle, is a deep sulcus, called the superior meatus of the nose. The upper turbinated bone (*Concha Morgagni*), a small scroll, constitutes the upper margin of this meatus. The inferior internal margin of the cellular portion of the ethmoid is formed by another scroll of bone, running its whole length. This is the middle turbinated bone (*Concha media*). Moreover, from the inferior margin of the cellular portion, one or more laminæ, of an irregular form, project so as to diminish the opening into the upper maxillary sinus.

The cells in the ethmoid bone are numerous and large, the posterior

[1] The observations of Dr. Leidy go to prove that there are two foramina nearly on a line, one with the other, at the front of the cribriform plate. The most internal one, that next to the crista galli, is occupied by a process of dura mater, and the most external, not so elongated in its shape as the other, transmits the internal nasal nerve.

ones (*cellulæ palatinæ*) discharge, by one or more orifices, into the upper meatus. The anterior (*cellulæ lachrymales*) discharge into the middle meatus of the nose by several orifices, concealed by the middle turbinated bone. The most anterior of these cells is funnel-shaped (*infundibulum*), and joining the frontal sinus, conducts the discharge of the latter into the nose.

In children of from three to eight years of age, there is attached to the posterior part of each cellular portion of the ethmoid a triangular hollow pyramid, consisting of a single cell. This pyramid arises, not only from the cellular portion, but also from the posterior margin of the cribriform plate, and of the nasal lamella, by which it gains a large and secure base. The processus azygos of the sphenoid bone is received between the two pyramids. In the base of the pyramid, communicating with the nose, is a foramen, which is known in adult life as the orifice of the sphenoidal sinus. The pyramid, towards puberty, becomes a part of the sphenoidal bone, and then detaches itself, by a suture at its base, from the ethmoidal. As life advances it is greatly developed, no indication of its original condition remains, and it becomes fairly the sphenoidal cell; singularly differing in shape from what it was in the beginning.[1]

Having been put upon the investigation of this pyramid by Professor Wistar, with the view of ascertaining its different phases of development, it has occurred to me to see it in every stage, from that of a simple triangular lamina, the cornet of Bertin (*Cornu Bertini*), arising from the posterior margin of the cribriform plate, to the hollow pyramidal state. The preceding anatomists described it but imperfectly; it remained for that distinguished individual to elucidate its real history.

Several of the articulations of the ethmoid have been mentioned; the remainder will be introduced with the bones of the face.

SECT. III.—OF THE FACE.

The face being situated at the inferior anterior part of the base of the cranium, is bounded above by this cavity, laterally by the zygomatic arches and fôssæ, and posteriorly by the space occupied by the pharynx. The best way of obtaining precise information concerning its form and composition is from the head of a child, of from five to ten years, in which the bones can be easily parted. In the adult, somewhat advanced in life, the bones cannot be separated perfectly, from their being united more or less together by the obliteration of their sutures.

The face is composed of fourteen bones, thirteen of which enter into the upper jaw. Twelve of the thirteen are in pairs: they are the ossa maxillaria superiora, ossa malarum, ossa nasi, ossa ungues, ossa turbinata inferiora, ossa palati. The thirteenth is the vomer. A

[1] Wistar's Anatomy, vol. i. p. 31, 3d edit.

single bone, with corresponding or symmetrical sides, constitutes the maxilla inferior.

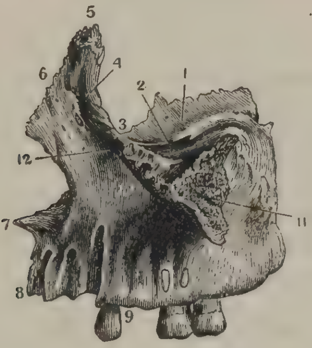
1. *Superior Maxillary Bones* (*Ossa Maxillaria Superiora, Maxillaires Supérieurs*).

These may be known by their superior size, and by their composing almost the whole front of the upper jaw. They are too peculiar in their figures to admit of comparison with any common object.

The superior face of these bones is formed by a thin triangular plate, the orbitar process, which is the floor of the orbit. In the posterior part of this plate is a groove, leading to a canal terminating in the front of the bone, at a foramen called infra-orbitar. This foramen is situated just below the middle of the lower margin of the orbit, and gives passage to the infra-orbitar nerve, and artery. Externally, the orbitar plate is terminated by a rough unequal triangular surface, the malar process, which articulates with the malar bone.

The nasal process arises by a thick, strong root, from the front upper part of the bone at its inner side. Its front edge is thin, the posterior margin is thicker, and the upper edge is short, being serrated for articulating with the os frontis. A deficiency exists between the orbitar

Fig. 38.



An external view of the Superior Maxillary of the left side.—1. Orbitar process. 2. Infra-orbitar canal. 3. Space for the os unguis. 4. Upper part of the lachrymal gutter. 5. Nasal process, and surface for articulating with the os frontis. 6. Surface for the nasal bone. 7. Anterior portion of the floor of the nostril. 8. Surface for articulating with its fellow. 9. Alveolar processes. 10. Depression just below the infra-orbitar foramen. 11. Surface for the malar bone. 12. Inferior orbitar foramen

process and the nasal process, for accommodating the os unguis, and the lachrymal sac. A groove (the lachrymal gutter), leading to the nose, is formed on the posterior face of the nasal process, and marks the situation and extent of the lachrymal sac. On that side of the root of the nasal process, next to the cavity of the nose, a small transverse ridge is seen (*Crista turbinalis inferior*), to which is attached the anterior part of the inferior turbinated bone.

The under surface of the os maxillare superius is marked by the alveolar processes for lodging the teeth. These processes are broader behind than before, corresponding in that respect with the teeth.

Within the circle of the alveoli is the palate process, arising from the internal face of the body of the bone. The palate process has a thick root, is thin in the middle, and, where it joins its fellow, has its margin turned upwards towards the nose into a spine or ridge (*Crista nasalis*). The anterior end of the nasal crest is terminated by a pointed production of bone, the anterior nasal spine (*Spin. nasal. anter.*), whereby its articular surface is increased. It presents an oblong concave surface above, constituting the floor of the nostril; below, it, with its fellow, and the alveolar processes, form one concavity, having a surface somewhat rough, which is the roof of the mouth. The palate process does not extend the whole length of the superior maxillary bone, but stops half an inch short of it, posteriorly, and with a serrated margin for the palate bone. When the two maxillary bones are in contact, we find in the suture, just behind the front alveolar processes, the foramen incisivum, which bifurcates, above, into each nostril. This foramen contains a branch of the spheno-palatine nerve, and a ganglion formed from it.

In front, just below the infra-orbitary foramen, the bone is depressed, which depression is filled up in the living state with fat and muscles. But, behind, the maxillary bone is elevated into a tuberosity, between which and the malar process is a broad groove, in which the temporal muscle plays.

The inner face of the upper maxillary bone presents a view of the large cavity in the centre of it, called Antrum Highmorianum. The orifice by which this cavity communicates with the nose is much diminished by the palate bone behind, the ethmoid above, and the inferior spongy bone below. When the antrum is cut open, a canal is seen on its posterior part, which conducts the nerves of the molar teeth to their roots, and a similar canal is seen in front of the antrum, for the nerves of the front teeth. The nerves, in both instances, come from the infra-orbitary. The nerves, till they begin to divide into filaments, are between the lining membrane and the antrum, but afterwards they make complete canals in the alveolar processes. The antrum frequently communicates with the frontal sinus, through the anterior ethmoidal cells, which circumstance is omitted by most anatomists.

This bone is articulated with the frontal, nasal, unguiform, malar, and ethmoid, above; to the palate bone behind; to its fellow, and to the vomer, at its middle; and to the inferior spongy bone by its nasal surface.

In the earlier periods of fœtal life (from the fortieth to the fiftieth day), there is found at the anterior part of the palate suture, at a point belonging to the two future incisor teeth on each side, a distinct piece of ossification corresponding with the Inter-maxillary bones of animals, and called after the same name in man. In cases of double hare-lip, it remains permanently distinct from the upper maxillary bones, and is in a movable state, as I have lately found in a child two and a half years old, upon whom I operated. Its motion could be readily felt upon the anterior part of the vomer. It had produced the incisor

teeth, which were extracted twelve or eighteen months preparatory to the operation. As a general rule, however, the only trace of the intermaxillary bone is a line, sometimes found at birth extending in a curved direction from the incisive foramen to the alveolar septum between the outer incisor and the canine tooth. M. J. Weber claims to have separated the intermaxillary from the maxillary in infants of one and two years, by the effect of acids.[1] In a human embryo of nearly two inches in length, and presumed to be from sixty to seventy days old, Dr. Leidy found these intermaxillary bones to be one and two-thirds of a line in breadth, and one line in height.[2]

Fig. 39.

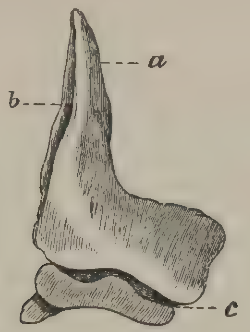


Fig. 39 represents the antero-inferior surface of the separate Intermaxillary Bone, much magnified, from the left side, but reversed by the camera. *a*. Ascending or nasal process. *b*. Articulating surface for the superior maxillary bone. *c*. Incisive alveoli.

2. *Palate Bones* (*Ossa Palati, Palatins*).

The palate bones, two in number, are placed at the back part of the superior maxillary, between them and the pterygoid processes of the sphenoid.

For descriptive purposes they may be divided into three portions—the horizontal or palate plate, the vertical or nasal plate, and the orbitar or oblique plate, placed at the upper extremity of the latter.

The palate plate is in the same line with the palate process of the superior maxillary bone, and supplies the deficiency caused by its abrupt termination. It is square. The inferior surface is flat, but rough for the attachment of the lining membrane of the mouth. The superior surface is concave, and forms about one-third of the bottom of the nose. The anterior margin is serrated where it articulates with the palate process of the maxillare superius. The posterior margin is thin and crescentic. The internal extremity of the crescent is elongated into a point (*spina nasalis posterior*), from which arises the azygos uvulæ muscle. The internal margin of the palate plate is thick and serrated for articulating with its fellow, the upper edge of it (*crista nasalis*) being turned upwards to join the vomer. The exterior edge

[1] Bischoff, Traité de Dévelop. p. 393.
[2] Proceed. Acad. Nat. Sc. of Philad., January, 1849.

touches the internal side of the maxillare superius, and from it arises the nasal plate.

The nasal plate forms the posterior external part of the nostril, and is much thinner than the palate plate. Its side next the nose is slightly concave, and is divided into two unequal surfaces, of which the lower is the smaller, by a transverse ridge (*crista turbinalis inferior*), that receives the posterior extremity of the lower turbinated or spongy bone. The external face is in contact with the internal face of the maxillary bone, and presents a surface corresponding with it. The nasal plate of the palate bone diminishes the opening into the Antrum Highmorianum by overlapping it behind. Backwards it joins the pterygoid process of the sphenoid bone, and overlaps its anterior internal surface.

At the inferior and posterior part of the nasal plate, where the crescentic edge of the palate plate joins it, the palate bone is extended into a triangular process, called the pyramidal (*Processus pyramidalis*) or pterygoid. This process, on its posterior surface, presents three grooves, the internal of which receives the internal pterygoid process of the sphenoid bone, and the external groove receives the external pterygoid process of the same bone. The middle fossa has its surface continuous with the pterygoid fossa of the sphenoid bone, and may be seen, in the articulated head, to contribute to this fossa. The anterior surface of the pyramidal process of the palate bone presents a small serrated tuberosity, which is received into a corresponding concavity on the posterior surface of the maxillary bone, and contributes to the firmer junction of the two.

Fig. 40.

Right Palate Bone seen from behind.—1. Palate plate. 2. Nasal plate. 3, 10. Pterygoid process with its three grooves, one of which is in the middle. 4. Crista nasalis and internal surface of palate plate. 5, 11. Posterior margin of palate plate. 6. Crista turbin. inferior. 7. Spheno-palatine notch or foramen below which is seen the sphenoidal process. 8, 9. Orbital plate, 9 being at the ethmoidal surface.

On the external surface of the nasal plate, between it and the base of the pyramidal or pterygoid process, a vertical groove is formed, which is converted into a complete canal by the maxillary bone. The lower orifice of this canal is near the posterior margin of the palate. It is called the posterior palatine foramen, and transmits the palatine nerve and artery to the soft palate. Immediately behind this canal there is, not unfrequently, a smaller one, running through the base of the pyramidal process of the palate bone, and transmitting a filament of the same nerve to the palate.

The upper extremity of the nasal plate is formed by two processes, one in front and the other behind, separated either by a round notch or a foramen. The posterior of the two, called sphenoidal process (*Processus Sphenoidalis*), also pterygoid apophysis, is inclined over towards the cavity of the nose. It is thin, and fits upon the under surface of the body of the sphenoid bone, and upon the inner surface of the internal base of the pterygoid process of the same. Its upper edge touches the base of the vomer. The anterior process is the orbitar portion of the palate bone.

The orbitar portion or plate is longer than the sphenoidal process, and is hollow and very irregular. It may be seen in the posterior part of the orbit wedged in between the ethmoid and maxillary bone. The portion of it which is there found is the orbital face, and is triangular. On the side of the ethmoid bone its cells are seen, which are completed by their contiguity to the ethmoid and sphenoid. The cells, in young subjects, are not always to be met with. The posterior face of the orbitar portion is winding, and looks towards the zygomatic fossa.

The notch between the orbitar portion and the pterygoid or sphenoidal apophysis, is converted into a foramen, by that part of the body of the sphenoid bone which is immediately below the opening of the sphenoid cell. Through this foramen, called spheno-palatine, pass the lateral nasal nerve, the spheno-palatine artery and vein.

This bone can scarcely be studied advantageously except in the separated head. A single application of it to the maxillary will then show how it extends from the palate of the mouth to the orbit of the eye, and how it is the connecting bone between the maxillary bone and the pterygoid process of the sphenoid.

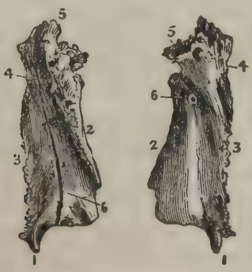
The palate bone articulates with six others. With the upper maxillary, the sphenoid, the ethmoid, the inferior spongy, the vomer, and with its fellow. The places of junction have been pointed out in the description of the bone.

3. *Nasal Bones* (*Ossa Nasi, Os du Nez*).

The ossa nasi, two in number, fill up the vacancy between the nasal processes of the superior maxillary bones. They are oblong and of a dense compact structure, being so applied to each other as to form a strong arch called the bridge of the nose, which is farther sustained by the nasal spine and the contiguous oblique serrated surface of the os frontis.

The ossa nasi are thick and serrated at their upper margins; below, they are thin and irregular. The surfaces by which they unite with

Fig. 41.



An anterior and posterior view of the Left Nasal Bone. *Right-hand figure.*—Bone seen in front. 1. Inferior extremity. 2. Articulating surface for its fellow. 3, 4. Margin for the nasal process of the superior maxillary bone. 5. Articular face for the os frontis. 6. Foramen for a nutritious vessel. *Left-hand figure.*—Bone seen from behind. 1. Inferior extremity. 2. Surface for its fellow. 3, 4. Margin for the superior maxillary. 5. Surface for the os frontis. 6. Groove for the internal nasal nerve.

each other are broad, comparatively smooth, with the exception of one or two small serrated processes, and have their edges raised into a small crest (*crista nasalis*), where they join the nasal lamella of the ethmoid bone. The edge by which they join the nasal process of the upper maxillary bone is curved; the upper part of this edge is overlapped by the nasal process, but the lower part of it overlaps the nasal process. There is a faint serrated arrangement also along this edge, to afford stronger adhesion to the nasal process.

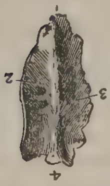
On the posterior face of the os nasi is to be seen a small longitudinal groove, formed by the internal nasal branch of the ophthalmic nerve, which nerve occupies the foramen orbitale anterius in the cribriform plate of the ethmoid bone.

The ossa nasi articulate with each other in front, with the nasal processes of the upper maxillary behind, with the septum narium, where they are in contact with one another, and with the os frontis above.

4. *Unguiform Bones* (*Ossa Ungues, Os Lacrymaux*).

The unguiform is a very small thin bone, apt to be incompletely ossified, so that it puts on a cribriform condition; it is placed at the internal side of the orbit, between the nasal process of the upper maxillary and the os planum of the ethmoid. Its orbitar surface is divided into a face which is in a line with that of the os planum, and into an oblong vertical excavation, the lachrymal gutter, continuous with the concavity on the posterior surface of the nasal process, for lodging the lachrymal sac. These surfaces are well defined the one from the other by a ridge, sharp and elevated below, and which may be called the lachrymal crest (*crista lachrymalis*). Its inferior anterior corner is elongated into the nose, so as to join with a process of the inferior turbinated bone, whereby the ductus ad nasum is rendered a complete bony canal.

Fig. 42.[1]



An anterior view of the Os Unguis of the left side.—1. Superior extremity. 2. Fossa for the lachrymal sac. 3. Orbitar plate and side in line with os planum. 4. Inferior extremity.

This bone lies on the orbitar side of the most anterior ethmoid cells, and completes them in that direction.

An important variety in the structure of this part of the orbit occasionally occurs, in which the whole fossa for lodging the lachrymal sac is formed by the unusual breadth of the nasal process of the upper maxillary bone. In this case, the only part of the os unguis which exists is that in the same plane with the os planum. Several examples have come under my own notice. Duverney has also mentioned it. Sometimes the os unguis is entirely wanting, in which case the os planum joins the nasal process.[2] A variety still more uncommon is mentioned by Verheyen, where the lachrymal fossa is formed exclusively by the os unguis.

This bone articulates very loosely with the adjoining bones, so that

[1] The reference numbers are here inverted.
[2] Bertin, Traité D'Osteol. vol. ii. p. 143, Paris, 1754.

it is frequently lost from the skeleton. It joins the os frontis above, the os maxillare superius before and below, the os planum behind, and the inferior spongy bone in the nose.

5. *Cheek Bones* (*Ossa Malarum, Jugalia, Os de la Pommette*).

These bones, two in number, are also called zygomatic by many anatomists. They are situated at the external part of the orbit of the eye, and form the middle external part of the face.

The cheek bone is quadrangular, and has irregular margins. It consists of two compact tables, with but little intermediate diploic structure.

There are three surfaces to it. That which contributes to the orbit is crescentic, and is called the internal orbitar process. The exterior one is prominent, and forms part of the surface of the face; the third surface is excavated, and forms a part of the zygomatic fossa. Of the four margins, two are superior, and two inferior. The anterior of the first two is concave, and rounded off, to form the external and one-half

Fig. 43.

An anterior view of the Malar Bone of the right side.—1. Inferior orbitar process. 2. Internal orbitar process. 3. Superior orbitar process for articulating with the os frontis. 4. Zygomatic process. 5. Maxillary process. 6. Surface for the superior maxillary bone. 7. Nutritious foramen.]

of the lower edge of the orbit. The posterior upper border above is thin and irregular, and to it is attached the temporal fascia: it terminates behind by a short serrated margin, for articulating with the zygomatic process of the temporal bone. The anterior inferior margin is serrated its whole length, for articulating with the superior maxillary bone. The posterior inferior margin gives origin to part of the masseter muscle. Some anatomists admit, also, to this bone a fifth margin, which is towards the bottom of the orbit, part of which articulates above with the great wing of the sphenoid bone, and another part joins below with the superior maxillary. Between these two parts is a notch, forming the outer extremity of the spheno-maxillary fissure.

The angles of this bone are called processes. The upper one, which is continuous with the external angle of the os frontis, is the superior orbitar, or angular process. The orbitar margin terminates below, in the inferior orbitar, or angular process. That portion of the bone which joins with the zygoma of the temporal is the zygomatic process; and

the fourth angle is the maxillary process, in continuation with which is the triangular serrated area, for union with the upper maxillary bone.

The os malæ articulates with four bones; to wit, with the maxillary, frontal, sphenoidal, and temporal.

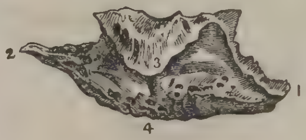
There are some few small foramina in this bone, which transmit nerves, being filaments from the first and second branch of the trigeminus; and also blood-vessels. There sometimes exists in it a cavity (the *sinus jugalis*), communicating with the antrum Highmorianum.

6. *Inferior Spongy Bones* (*Ossa Spongiosa aut Turbinata Inferiora, Cornets Inferieurs*).

This pair of bones is situated at the inferior lateral parts of the nose, just below the opening into the antrum Highmorianum. They are very thin and porous, and their substance is extremely light and spongy.

The internal face of the spongy bone is towards the septum of the nose, and is an oblong rough prominence. The external face is a corresponding concavity towards the maxillary bone. The superior margin presents, in front, an upright process, which joins with the anterior inferior angle of the unguiform bone, to form the nasal duct. Just behind this, the margin of the bone is turned over towards the antrum,

Fig. 44.



An external view of the inferior Spongy Bone of the right side.—1. Anterior extremity, for resting on the ridge of the upper maxillary. 2. Posterior, for resting on the ridge of the palate bone. 3. Hooked portion, for resting on the lower margin of the antrum Highmorianum. 4. Its inferior border.

forming a broad bend or hook, which rests upon the lower margin of the orifice of the antrum, and diminishes its size. From the superior margin, also, one or two processes not unfrequently arise, whereby this bone joins the ethmoid. The inferior margin is somewhat thicker than the superior.

The anterior extremity of this bone rests upon the ridge (*crista turbinalis*) across the root of the nasal process of the upper maxillary. The posterior extremity rests, in like manner, upon the ridge across the nasal plate of the palate bone.[1]

The Ploughshare (*Vomer*).

This single bone is placed between the nostrils, and forms a considerable part of their septum. It is frequently more inclined to one side than to the other. It is formed of two laminæ, between which there is a very thin diploic structure.

[1] In some rare cases this bone adheres to the ethmoid, so as to become a part of it.

The sides of the vomer are smooth and parallel. It has four margins. The superior is the broadest, and has a furrow in it for receiving the azygous process of the sphenoid bone. The anterior margin being directed obliquely downwards and forwards, its front part joins the cartilaginous septum of the nose, and the posterior part receives, in a narrow groove, the nasal plate of the ethmoid.

Fig. 45.[1]

The Vomer.—1. Posterior margin terminating the septum of nose. 2. The superior margin hollowed to receive the azygous process of the sphenoid bone. 3. Inferior margin. 4. Superior margin which joins nasal plate of ethmoid.

The posterior margin of the vomer is smooth and rounded, making the partition of the nostrils behind. The inferior margin articulates with the spine or ridge (*crista nasalis*) of the superior maxillary and palate bones, which exists at their internal border.

Lower Jaw (*Os Maxillare Inferius, Maxillaire Inferieur*).

This bone forms the lower boundary of the face, and is the only one in the head capable of motion. In early life, its two halves are separable, being joined at the middle line only by cartilage; but, in the course of two or three years after birth, they are consolidated, and the original cartilage disappears.

It consists of a body or region which corresponds with the teeth, and two extremities or branches.

The inferior part of the body presents a thick and rounded edge, which is the base. The upper part of the body is formed by the alveolar processes for receiving the teeth. The line of union between the halves, being called the symphysis, is marked in front by an elevated ridge (*crista or spina mentalis externa*), terminated below by a triangular rising of the anterior mental tubercle. In many subjects this tubercle is bounded on each side by a rounded prominence of bone, which gives to the fore part of the jaw an unusual squareness in the living subject. Just above the latter prominence, there is, on each side, a transverse depression, from which arises the levator muscle of the lower lip. On a line with this depression, and removed a little distance from its external extremity, under the second bicuspate tooth or the interstice between it and the first large molar tooth, is the anterior mental or maxillary foramen, the termination of a large canal in either side of the bone, which conducts the inferior maxillary blood-vessels

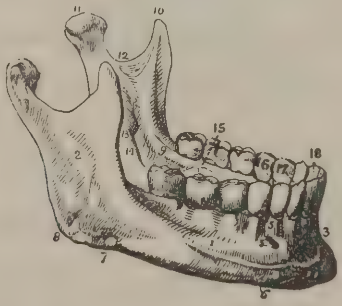
[1] Reference numbers inverted.

and nerve to the teeth. The foramen is directed obliquely upwards and backwards, and transmits the remains of these blood-vessels and of the nerve to the face. The chin is that part of the bone between the anterior mental foramina. As the alveolar processes do not exist in early life, and in very advanced age when the teeth are lost, the anterior mental foramen in such cases is very near the superior margin of the bone. At it an obtuse ridge of bone commences, and which ends in the root or anterior edge of the coronoid process. The alveolar processes of the last three molar teeth are placed within this ridge, and project over the internal face of the bone.

The internal or posterior face of the lower jaw is also marked at the symphysis by a ridge (*crista or spina mentalis interna*) passing from the superior to the inferior margin. At the lower part of this ridge is a cleft process, sometimes quadrate, the posterior mental tubercle, for the muscles of the tongue. Below this tubercle, on either side, is a shallow fossa, for receiving the digastric muscle. Between the lower margin of the bone and the protuberance occasioned by the alveolar processes of the larger molar teeth, is an oblong large fossa made for the reception of the submaxillary gland; a small horizontal ridge above it marks the attachment of the mylo-hyoid muscle, and just above that there is another depression for the sublingual gland.

The alveolar processes form a semicircle, the extremities of which are carried backwards with a slight divergence. The parietes of the

Fig. 46.



The inferior Maxillary Bone. 1. The body. 2. The ramus. 3. The symphysis. 5. Alveolar processes. 5. Bis-anterior mental foramen. 6, 7. The base. 8. The angle. 9. Extremity of the ridge for the mylo-hyoid muscle. 10. Coronoid process. 11. Condyle. 12. Crescentic edge from the condyloid to the coronoid process. 13. Posterior mental foramen. 14. Groove for the mylo-hyoid nerve. 15. Molar teeth. 16. Points to bicuspate teeth of right side. 17. Points to cuspate tooth of right side. 18. Incisors.

processes are thin, and present cutting edges. They of course correspond, in number and shape, with the roots of the teeth which they have to accommodate. The anterior ones are deeper than the posterior. As a general rule, the alveolar processes may be said to come and depart with the teeth; but, when a single tooth is extracted, the alveolar cavity not unfrequently is filled up with osseous matter, the edge of it alone being removed. This occurs more frequently in the lower than in the upper jaw.

The base of the lower jaw does not present many marks worthy of

attention. It should be observed that its anterior part is thicker than the posterior; and that sometimes, just before the angle of the bone, we see a concave curvature of this edge, but generally it is straight, or nearly so.

The extremities or rami of the lower jaw are quadrilateral, and rise up much above the level of the body. The superior margin presents a thin concave edge, bounded in front by the coronoid, and behind by the condyloid process. The coronoid process is triangular, and receives the insertion of the temporal muscle; its base is thick, but its apex is a thin rounded point. The condyloid process is a transverse cylindrical ridge, directed inwards, with a slight inclination backwards, its middle being somewhat more elevated than the extremities. It springs from the ramus by a narrow neck. There is a concavity at the inner fore-part of its neck, for the insertion of the pterygoideus externus, and a convexity behind.

The external face of the ramus is flat, but marked by the insertion of the masseter muscle. The internal face, at its lower part, is flat and rough, for the insertion of the pterygoideus internus. At the upper part of this roughness, near the centre of the ramus, is the posterior mental or maxillary foramen, through which the inferior maxillary vessels and nerve pass. It is partially concealed by a spine of bone, into which the spino-maxillary ligament from the os sphenoides is inserted. Leading from this foramen is a small superficial groove, made by a filament of the inferior maxillary nerve.

The angle of the inferior maxillary bone, formed by the meeting of the base and the posterior margin of the ramus, presents diversities well worth attention, at different epochs of life, and in different individuals. In very early life, and in very advanced, when the alveoli are absorbed, it is remarkably obtuse. In most middle-aged individuals it is nearly rectangular. Besides which, its corner is sometimes bent outwards and sometimes inwards, increasing or diminishing thereby the breadth of the face at its lower part.

The substance of this bone, externally, is hard and compact. Internally there is a cellular structure, through the centre of which runs the canal for the nerves and blood-vessels. From this canal smaller ones are detached, containing the vascular and nervous filaments which go to the roots of the teeth. The condyles, or condyloid processes of the os maxillare inferius, articulate with the temporal bones by means of their glenoid cavities.

Remarks.—The os maxillare inferius has a greater influence on the form of the face than any other bone entering into its composition. Sometimes it is much smaller in proportion in certain individuals than in others. Sometimes its sides, being widely separated, cause a great shortening to the chin, and breadth to the lower hind part of the face. In many instances, the alveolar processes, in front, incline obliquely over the outer circumference of the bone, and thereby give to the chin the appearance of receding considerably. In others, the alveoli incline over the inner circumference, which causes the chin to project unusually.

CHAPTER III.

GENERAL CONSIDERATIONS ON THE HEAD.

Having described the individual bones of the head, it will now be proper to consider it as a whole.

SECT. I.—OF THE DIPLOIC STRUCTURE OF THE CRANIUM.

The bones of the cranium, in the adult, consist of an external and of an internal table; united by a bony reticulated or cellular substance, which does not manifest itself very distinctly till two, three, or even more years are passed by the infant. The internal table of the skull is thinner and more brittle than the external, and has obtained, from that cause, the name of vitreous table. In the male adult, the flat bones of the cranium where they are much exposed, as above the parietal ridge and in front and behind, are about three lines in thickness, on an average; but there are individual peculiarities departing much from this rule, reducing it to one-half or more than doubling it, besides making the thickness very unequal.

The cells of the diploic structure are not to be confounded with the large sinuses already described, that exist in the frontal, the temporal, and the sphenoidal bones. They are formed under different circumstances, and do not communicate with them. The sinuses are lined by a mucous membrane, whereas the lining membrane of the cells of the diploë corresponds with the endosteum or internal periosteum of other bones. I have a preparation, in which a diploic structure of the os frontis exists between its sinuses and the external table of the bone: in the same head, a similar circumstance existed in regard to the temporal bone; from which we infer that the diploic structure, in these places, is caused to recede, and even to be partially obliterated, when the development of the sinus commences, which is not until some time after the evolution of the diploic structure. The sphenoidal bone, when fully evolved in its body, is a remarkable instance of the recession of diploic structure for the purpose of forming a sinus.

In the diploë of the dried bones, several arborescent channels may be seen by the removal of the external table.[1] They were discovered about the year 1805, by M. Fleury, while he was Prosector at the School of Medicine in Paris: and engaged, at the instigation of M. Chaussier, in some inquiries relative to the structure of the cranium. The account given by the latter is, that these channels are occupied in the recent subject, by veins, which, like all others, are intended to return the blood to the heart. These veins are furnished with small

[1] Chaussier, Exposition de la Structure de l'Encephale, Paris, 1807.

valves, have extremely thin and delicate parietes, and commence by capillary ramifications, coming from the different points of the vascular membrane, which lines the cells of the diploë. Their roots are at first

Fig. 47.

A view of the Skull deprived of its outer table, so as to show the diploic structure. The arborescent dark lines indicate the channels for the diploic sinuses or veins.

extremely fine and numerous, form by their frequent anastomoses a kind of net-work, and produce by their successive junction, ramuscles, branches, and large trunks, which, becoming still more voluminous, are directed towards the base of the cranium. Some variations exist in regard to the number, size, and disposition of these trunks; but generally, one or two of them are found on either side of the frontal bone, two in the parietal bone, and one on either side of the occipital bone. Anastomoses exist between these several trunks, by which the veins in the parietal bone are joined to those in the frontal and in the occipital. Branches from the right side of the head also anastomose with those from the left side. Besides the branches already mentioned, one or two, smaller than the others, are directed towards the top of the head, and terminate in the longitudinal sinus.

The descending veins of the diploë communicate in their passage with the contiguous superficial veins, and empty into them the blood which they receive from the several points of the diploë. These communications are passed through small foramina, which penetrate from the surface of the bone to the diploë. The trunks of such diploic veins as are continued to the base of the cranium open partly into the sinuses of the dura mater, and partly into the venous plexus at the base of the pterygoid apophyses of the sphenoid bone, and form there the venous communications through the foramina of the base of the cranium, called the emissaries of Santorini. Moreover, there are communications sent from the diploic veins, through the porosities of the internal table of the skull, to the veins of the dura mater. This fact is rendered very evident by tearing off the skull-cap, when the surface of the dura mater will be studded with dots of blood, and the internal face of the bone also, particularly in apoplectic subjects. It appears, indeed, that the arteries of the cranium are principally distributed on its external surface, and the veins on its internal surface and diploë.

In the infant, the diploic veins are small, straight, and have but few branches: in the adult, they correspond with the description just given, and, in old age, they are still more considerable, forming nodes and seeming varicose. In children, when the bones are diseased, they partake of the latter character. In order to see them fully, the external table of the skull must be removed, both from its vault and base, with a chisel and mallet. This operation will be much facilitated by soaking the head previously in water for two days.

The diploic sinuses, as well as the corresponding channels in the bodies of the vertebræ, are now considered as an enlarged condition of Haversian canals.

SECT. II.—OF THE SUTURES.

Except in advanced age, the bones of the cranium and of the face are very distinctly limited, but also united by sutures.

The latter are formed by the proximate edges of the contiguous bones presenting a multitude of sharp serrated points, and of deep narrow pits, by which they interlock by an accurate and firm contact. Here and there, in the sutures which unite the flat bones of the cranium, we find not only sharp points, but complete dove-tail processes of the one bone received into corresponding cavities of the other. The denticulation of the sutures is much more common, and much better marked, on the external than on the internal surface of the cranium. On the latter, the union of the bones is, in several instances, in a line nearly straight; in which case, the denticulation is almost exclusively confined to the external table and to the diploic structure.

The Coronal Suture (*Sutura Coronalis*), so named from its corresponding in situation with the garlands worn by the ancients, begins at the sphenoid bone, about an inch and a quarter behind the external

Fig. 48.

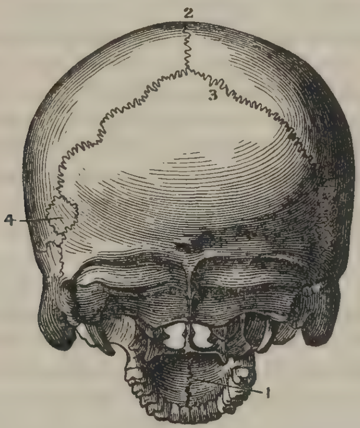
A view of the outside of the Vault of the Cranium, showing the Sutures.—1. The coronal suture. 2. The sagittal suture. 3. The lambdoidal suture.

angular process of the os frontis. It inclines so much backwards in its ascent, that when we stand erect, with the head in its easiest position, a vertical line, dropped from its point of union with the sagittal suture, would pass through the centre of the base of the cranium, and would cut another line drawn from one meatus auditorius externus to the other. It unites the frontal bone to the two parietal.

The Sagittal Suture (*Sutura Sagittalis*) unites the upper margins of the two parietal bones, and is immediately over the division between the hemispheres of the cerebrum. It has been stated, in the account of the os frontis, that sometimes it is continued through the middle of this bone down to the root of the nose.

The Lambdoidal Suture (*Sutura Lambda-formis*) is named from its resemblance to the Greek letter lambda, and consists of two long legs united angularly. It begins at the posterior termination of the

Fig. 49.



A posterior and inferior view of the Head.—1. The middle palate suture. 2. Posterior end of the sagittal. 3. The lambdoidal. 4. Os Wormianum.

sagittal suture, and continues down to the base of the cranium, as far as the jugular eminences of the occipital bone. Its upper half unites the occipital to the parietal bones, and the lower half the occipital to the temporal bones. The latter half is sometimes called the Additamentum Suturæ Lambdoidis.

The Squamous Suture (*Sutura Squamosa*) is placed on the side of the head, and unites the parietal to the temporal bone. The convex semicircular edge of the latter overlaps the concave edge of the former. It differs from other sutures by the defect of serrated margins, and by the edge of one bone reposing upon the edge of the other. The squamous suture is converted into the common serrated one, where the upper edge of the angle of the temporal bone joins the parietal. This portion is called the Additamentum Suturæ Squamosæ.

The squamous mode of suture unites, likewise, the great wing of the sphenoidal to the temporal angle of the parietal.

In the upper part of the lambdoidal suture, particularly, we find in many skulls one or more small bones, connected to the parietal and occipital bones by serrated margins. They are called the Ossa Wormiana or Triquetra. They vary very much in their magnitude, being in different subjects from a line to one inch, or an inch and a-half in diameter. I have seen them of the latter size, and even larger, occupying entirely the place of the superior angle of the os occipitis. Most commonly, but not always, when one of these bones exists on one side of the body, a corresponding one exists on the other. A congeries of these bones, united successively, is sometimes found in the lambdoidal suture; in such cases they are, for the most part, small. Commonly these bones consist, like the other bones of the cranium, of two tables and an intermediate diploë, and form an integral portion of the thickness of the cranium; sometimes, however, they compose only the external table. M. Bertin says, that he has seen them, also, composing only the internal table of the cranium.

All the sutures mentioned besides the lambdoid, may exhibit, at any of their points, the Ossa Triquetra or Wormiana. We have examples of them in the coronal, the sagittal, and the squamous, but in such cases they are small. The lambdoid unquestionably has them most frequently. M. Bertin has seen a large square bone at the fore part of the sagittal suture, occupying the place, and presenting the form, of what was once the anterior fontanel: he has also seen triquetral bones in the articulations of the bones of the face.[1]

The sutures described belong exclusively to the cranium, but there are others common to it and to the face. The sphenoidal suture surrounds the bone from which its name comes; the ethmoidal suture surrounds the ethmoidal bone; the zygomatic suture unites the temporal and malar bones; the transverse suture runs across the root of the nose, and also unites the malar bones to the os frontis. The middle palate suture unites the palatine processes of the palate and of the upper maxillary bones respectively; the transverse palate suture crosses the hard palate. In the same way the other articular lines of the face derive their names from the bones they unite, and do not merit a particular attention at this time, as enough has been said in the description of the bones themselves.

The base of the cranium is remarkably different, in the manner of its articulations, from the upper part. The surface, in the first place, is very rugged, and much diversified by its connection with muscles and bones: besides which, there is a considerable number of large foramina and fissures in it for the blood-vessels and nerves. To guard against the weakness arising from the latter arrangement, nature has given a very increased thickness to the base, particularly where much pressure from the weight of the head exists, and has applied unusually broad surfaces of bone to each other to secure them from displacement by

[1] Bertin, Traité d'Osteol.

concussion, and different kinds of violence. These arrangements are particularly manifest at the junction of the cuneiform process of the occipital bone with the body of the sphenoid, which, in middle age, or rather shortly after puberty, is, as stated before, anchylosed or synostosed, at the lower part of the lambdoidal suture, and at the margins of the petrous portion of the temporal bones where they touch the contiguous bones. Hence it results, that the several fastenings of the base of the cranium, and also of the upper maxilla, are so complete and strong, that they are most generally perfectly exempt from dislocation, and when the violence offered to them is sufficiently great, the bones, in place thereof, are fractured.

The use of the sutures, in the cranium and upper maxilla, is somewhat problematical; for as none of the bones move, the head might have been equally well arranged by being made of a single piece. In proof of which it is only necessary to recollect, that in the very aged there is frequently not a bone of the cranium and upper maxilla to be found in an insulated state: they are all blended with the adjoining bones, by the obliteration of their sutures. The old notion that sutures existed for the purpose of arresting the course of fractures, and for opening in some diseased conditions of the brain, has been very justly exploded. We know that a fracture will traverse a suture readily, and that the opening of the sutures from hydrocephalus is an occurrence only of very early infancy, where the sutures have not arrived at the serrated and dove-tail arrangement by which they are subsequently secured. It is much more probable that the true ground for the existence of sutures is found among the laws peculiar to the growing state, and which most commonly are suspended after the several developments have been accomplished. Thus, the head, in consequence of being separated by sutures into many pieces, is more readily wrought, from its form and size in the embryo state, to the form and size required by adult life. This necessity of subdivision into many pieces does not depend so much on the size, as on the shape of the head, for we find the larger animals, as the elephant, having no more sutures than the smaller. This opinion is also sustained by what we see in other bones, bones of a very simple shape, as those of the tarsus and carpus, consisting from the very beginning of but one piece. But where the shape of a bone is complicated, we find it, while growing, submitted to the same law as the head at large, and consisting of many pieces. In such cases these pieces are united by a species of suture corresponding precisely with the form of suture observed between some of the bones of the cranium (as, for example, between the occipital and the sphenoid); thus, the os femoris, till adult age, consists of five pieces, its two articular extremities, its body, its trochanter major, and its trochanter minor. The cranium itself, before birth, and for some time after, has several of its individual bones consisting each of two, or more pieces; which favors still more the idea.

Some persons think that the sutures of the adult are only remains of an arrangement intended exclusively for the benefit of the parturient state, by maintaining a plasticity of the head of the fœtus, which admits of its diameters accommodating themselves to the diameters of

the pelvis of the mother. This theory is rather too exclusive, though it may be admitted that the sutures in a fœtal head have that use, and are in some cases of parturition a most fortunate coincidence, by which the lives of both parties are saved. But it should be observed that in a great number of cases, the head of the fœtus never changes its form in passing through the pelvis, because the passage is quite large enough without it; and, again, if the sutures were intended expressly for the parturient state, we ought not to find them in birds, and in such animals as are hatched, because the necessity for them there does not exist.[1]

Upon the whole we may safely conclude, that the sutures of the cranium and face are simply a provision for the growing state, and that, like all other provisions for this state, it also ceases at its appropriate period, and sometimes leaves not a vestige of its existence. Occasionally, indeed, we find the latter to have occurred in one or more sutures, even before the age of puberty, as I have repeatedly witnessed in the sagittal, the squamous, and the lambdoidal sutures.

The manner in which the sutures are formed is sufficiently interesting: they are generally said to be made by the radii of ossification, from the opposite bones meeting and passing each other, so as to produce a serrated edge. This explanation may account partially for the shape of the edge of the sutures, but not for their uniform position; inasmuch as we nearly always find the sutures in the same relative situation, and having the same course. If they depended exclusively on so mechanical a process, as the rays of one bone shooting across the rays of another by their own force, we ought to see, more frequently, the sagittal suture more on one side of the head than on the other, and not straight, because in some instances ossification is a more rapid process on one side than on the other. Moreover, in all cases where bones arise from different points of ossification, and meet, the serrated edge should be formed, and particularly in the flat bones. Observation, however, proves that the os occipitis, which is formed originally from four points of ossification, and therefore has as many bones composing it in early life, does not present these bones afterwards united by the serrated edge. The acromion process of the scapula, though originally distinct from the spinous, never unites to it by suture, but always by synostosis. The mode of junction in the three bones of the sternum is always by synostosis. In short, the observation holds good in numerous other instances.

Bertin and Bichat reject fully the mechanical doctrine concerning the sutures, and present one founded upon reason and observation, and susceptible of confirmation by any accurate observer. The dura mater and the pericranium, before calcification commences, form one membrane consisting of two laminæ. Partitions pass from one of these laminæ to the other, which mark off the shape, or constitute the mould of the bones long before they are perfected. The peculiar shape of

[1] A gentleman whose anatomical writings have some vogue in this country, has cut the Gordian knot, by telling us that they are "*accidental merely, and of little use!!*"—Anat. of the Human Body, by John Bell, Surgeon, Edinburgh.

the bony junction, or, in other words, of the sutures or edges of the bones in adult life, depends, therefore, exclusively upon the original shape of the partitions. When the latter are serrated, the points of ossification will fill up these serræ; but when they are oblique, the squamous suture will be subsequently formed.

This theory also accounts for modes of junction intermediate to the squamous and serrated suture; for the formation of the Ossa Triquetra or Wormiana; for their existence, form, size and number, in some skulls, and their total absence in others. The inference will also be obvious, that in all ossifications from different nuclei, a suture will not be formed, where the membranous partitions do not exist; but that the bones will unite after the manner of such as are fractured. We shall also understand, that when these partitions are weak and imperfect, either from their congenital condition, or from advanced age, as happens in all sutures, but with some differences of time, the bones of the opposite sides are blended together completely.

The partitions which determine the places of the sutures may be demonstrated in a young adult skull by removing with muriatic acid the calcareous portion of the bones, so as to leave only the animal part. On opening the suture after this process, it will be seen, that the pericranium sends in its partition, which is met by the partition coming from the dura mater. Or, if either of these membranes be peeled off, its contribution of partition will appear very plainly projecting from its surface, in the form of a ridge.

Owing to congenital hydrocephalus, the sutures of the vault of the cranium have been known to remain open for years after birth, from the continued augmentation of the volume of the brain. In such cases additional bones are sometimes formed, manifesting a strong attempt, on the part of nature, to cover the brain with bone. I obtained, several years ago, a specimen of this kind belonging to a fœtus of nine months, whose head was as large as it is commonly in adult life, and in whom there were two ossa parietalia on one side. Morgagni,* whose authority is proverbial in morbid anatomy, states, that a learned colleague and intimate friend of his, Bernardin Rammazzini, aged seventy, had the sutures open at that period of life. He does not say at what time this condition of them appeared. I think it more probable that they had never been closed, though Morgagni leaves the reader to infer that it was a circumstance which had arisen from a violent hemicrania with which the patient had been seized when he was advanced in life. Diemerbroeck found, in a woman of forty, the anterior fontanel not ossified. Bauhius' wife, aged twenty-six, had the sutures not yet closed. Indeed, there is no deficiency of well-authenticated similar instances, more of which it will be unnecessary to adduce. It may be observed here, that when from congenital hydrocephalus, attended with much extension of the brain, the bones of the cranium are compelled to grow beyond their usual diameters, they are uncommonly thin, and the diploic structure is very imperfectly developed; which will account for their separation at any period of life, from the fastening being so slight.

* Causes and Seats of Disease, Letter 3d, Art. 8th.

SECT. III.—THE INTERNAL SURFACE OF THE CRANIUM.

The points for study in viewing the cranium as a whole are generally the same as have been presented in the detail of each bone. It is, nevertheless, useful to regard the structure in its connected state, as new views are thus presented of the relative situation of parts, and of the formation of the several fossæ and cavities.

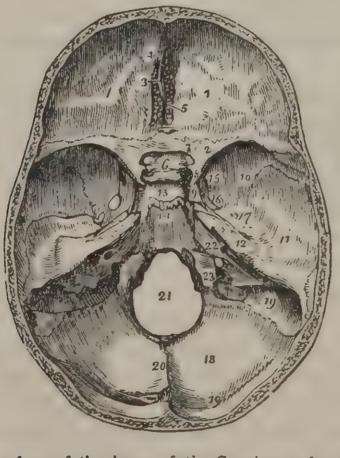
The interior of the cranium, or the cavity for containing the brain, is regularly concave above, and is there called the arch or vault; but below, it is divided into several fossæ, and is called the base.

The whole cavity is lined by the dura mater, and, in the adult, presents round superficial depressions made by the convolutions of the brain. These depressions are seldom deep enough to prevent the internal periphery of the vault and sides of the cranium from being nearly parallel with their external surface.

On the Vault, or arch, are to be seen, on the middle line, the internal frontal spine (*crista frontalis*), extending from the ethmoid bone half way or more up the os frontis: also, the gutter for the longitudinal sinus, leading from this spine along the sagittal suture, and terminating at the internal occipital protuberance. On either side of this gutter are the arborescent channels, made by the great middle artery of the dura mater. In this section, we also see the internal face of the os frontis, excepting its orbitar processes, the parietal bones; and the superior fossæ in the occipital bone, for the posterior lobes of the cerebrum.

The base of the cranium internally presents a very unequal surface,

Fig. 50.



A view of the internal surface of the base of the Cranium, after the vault has been removed. 1, 1. Anterior fossa for the anterior lobe of the cerebrum. 2. Lesser wing of the sphenoid bone. 3. Crista galli. 4. Foramen cœcum. 5. Cribriform plate. 6. Processus olivaris. 7. Foramen opticum. 8. Anterior clinoid process. 9. Groove for the carotid artery. 10. Greater wing of the sphenoid bone. 11. Middle fossa for the middle lobe of the cerebrum. 12. Petrous portion of the temporal bone. 13. Sella turcica. 14. Basilar gutter for the medulla oblongata. 15. Foramen rotundum. 16. Foramen ovale. 17. Foramen spinale. 18. Posterior fossa for the cerebellum. 19. Groove for the lateral sinus. 20. Ridge for the falx cerebelli. 21. Foramen magnum. 22. Meatus auditorius internus. 23. Posterior foramen lacerum for the jugular vein.

abounding in deep depressions, processes, and foramina. On its middle line, extending from before backwards, the following objects should be remarked: The foramen cœcum at the front of the crista galli, and, at either side of the latter, the ethmoidal gutter, perforated with holes. These gutters are bounded, laterally, by the internal margin of the orbitar processes of the os frontis, and behind by the sphenoid bone. At the fore exterior part of the gutter is the oblong foramen, for transmitting to the nose the internal nasal nerve, and about half an inch behind this foramen, in the suture, with the os frontis, is the inner orifice of the foramen, called the anterior internal orbitar, which leads the same nerve from the orbit. Immediately behind the ethmoidal fossæ the sphenoid bone presents a plain surface, upon which are placed the olfactory nerves and the contiguous part of the brain. Behind this plane, is the fossa, running from one optic foramen to the other, for lodging the optic nerves. Behind this, again, is the sella turcica, or pituitary fossa, bounded at its two anterior angles by the anterior clinoid processes, and behind by the posterior clinoid process. Posterior to the latter is a plain square surface (the *clivus* or declivity) of the sphenoid bone, continuous with the internal surface of the cuneiform process of the os occipitis. On the latter is the depression called basilar gutter, for receiving the pons Varolii, also the medulla oblongata, and which is bounded below by the great occipital foramen. From this foramen to the internal occipital protuberance, proceeds the inferior limb of the occipital cross.

On both sides of the ethmoidal bone is a convex surface, called, however, the anterior fossæ of the base of the cranium, and formed by the orbitar processes of the os frontis and the little wings of the sphenoid bone, for lodging the anterior lobes of the cerebrum. This surface is terminated behind by the rounded edge of the little wing, which is received into the fissure between the anterior and middle lobes of the brain. Just anterior to this edge is the fronto-sphenoidal suture.

On the sides of the sella turcica are the middle fossæ of the base of the cranium for lodging the middle lobes of the cerebrum. They are very wide externally, where they are bounded by the squamous portion of the temporal bones, but narrow internally, where they are bounded by the Sella Turcica. The little wings of the sphenoidal bone terminate them in front, and form there a crescentic edge hanging over their cavity. Their posterior margin is the superior ridge of the petrous bone. This bone is placed very obliquely, inwards and forwards, and at its point, almost reaches the posterior clinoid process. At the anterior part of the fossa, is the sphenoidal fissure or foramen of the sphenoidal bone. Just above the base of this fissure is the foramen opticum, partially concealed by the anterior clinoid process. Just below the base of the fissure is the foramen rotundum. At the point of the petrous bone, by the side of the posterior clinoid process, is the anterior orifice of the carotid canal. On a line with the latter, exteriorly, is the foramen ovale. Two lines behind the latter is the foramen spinale. The groove formed by the middle artery of the dura mater may be traced from the foramen spinale along the anterior margin of the squamous bone. Near the upper part of this bone the groove bifurcates; the

larger channel runs upwards into a groove on the tip of the great sphenoidal wing into the principal groove of the parietal bone, which commences at the temporal angle of the latter. The smaller groove runs horizontally backwards, and just above the base of the petrous bone is continued also in the parietal bone. On the front of the petrous portion may be seen the hiatus Fallopii. The sphenoidal suture runs through these fossæ, in the examination of which, the reception of the spinous process of the sphenoid bone, between the squamous and petrous portions of the temporal, will be readily understood.

On each side of the foramen magnum occipitis are the two posterior fossæ of the base of the cranium, formed by the posterior faces of the petrous bones, the angles of the mastoid portions of the temporal bones, and by that surface of the occipital bone below its horizontal ridges. These two fossæ are very partially separated by the inferior ridge of the occipital cross and receive the hemispheres of the cerebellum. The additament of the lambdoidal suture traverses these fossæ. At the junction between the petrous bone and the basilar process of the occipital, in the course of the suture, is a groove for the inferior petrous sinus. The groove conducts to the posterior foramen lacerum, which has a small part separated from it by the little spine of the petrous bone, which, with the assistance of the dura mater, forms a distinct foramen for the eighth pair of nerves. The posterior foramen lacerum being common to the temporal and occipital bones, is occasionally much larger on the right than on the left side; in which case, the groove that leads from it along the angle of the temporal bone, the inferior corner of the parietal, and the horizontal limb of the occipital cross, is also larger. Above the foramen lacerum are the meatus auditorius internus, and the internal orifice of the aqueduct of the vestibule. Between the foramen lacerum and foramen magnum occipitis, is the anterior condyloid foramen. The two posterior fossæ of the base of the cranium contain the cerebellum.

SECT. IV.—OF THE EXTERNAL SURFACE OF THE HEAD.

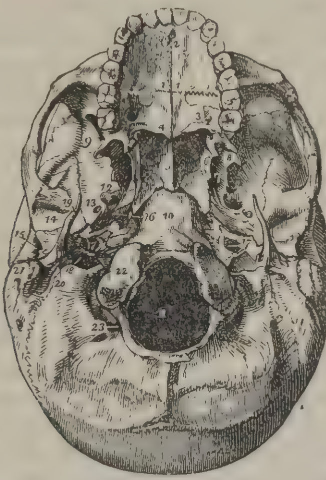
Anatomists consider the external surface of the head, or its periphery, as forming or representing three ovals and two triangles, each of which constitutes a region. The first oval is the whole superior convex part of the cranium; or, in other words, the external surface of its vault. The second oval is formed by the inferior surface of the cranium, and of the face. The third oval is formed by the lower front part of the os frontis, and by the face. Each side of the head forms one of the triangular regions.

The superior region is so simple, and its parts have been so closely sketched, that it is unnecessary to repeat the description.

The inferior region, or oval, extends from the chin to the occipital protuberance, and is bounded in its transverse diameter by the superior semicircular ridges of the os occipitis, by the mastoid processes, and by the rami and base of the lower jaw. This surface is subdivided into Palatine, Guttural, and Occipital sections or regions.

The Palatine region or section, is formed by the superior maxillary and palate bones above, and by the inferior maxillary bone laterally and below. It is a deep fossa, the circumference of which is represented by the letter U, the open part being behind. The whole upper surface of the palatine region presents a number of small rough elevations and fossæ, for the attachment of the lining membrane of the mouth. The surface is divided into two equal parts by the long or middle palate suture, which is crossed at its posterior part by the transverse palate suture. The posterior margin of the hard palate is concave on each side of the mouth, and from it is suspended the soft palate. The point in the centre of this margin (*spina nasalis posterior*) gives origin to the azygos uvulæ muscle.

Fig. 51.



An external view of the base of the Cranium. 1. The hard palate. 2. Foramen incisivum. 3. Palate plate of the palate bone. 4. Crescentic edge for the soft palate. 5. The vomer, separating the posterior nares. 6. Internal pterygoid process of the sphenoid bone. 7. Pterygoid fossa. 8. External pterygoid process. 9. Temporal fossa below the zygomatic arch. 10. Basilar process. 11. Foramen magnum. 12. Foramen ovale. 13. Foramen spinale. 14. Glenoid fossa. 15. Meatus auditorius externus. 16. Foramen lacerum anterius. 17. Carotid foramen. 18. Foramen lacerum posterius. 19. Styloid process. 20. Stylo-mastoid foramen. 21. Mastoid process. 22. The condyles of the occipital bone. 23. Posterior condyloid foramen.

The foramina on this surface are the anterior palatine or foramen incisivum, in the long palate suture just behind the incisor teeth ; and on either side, behind, between the palatine and pterygoid process of the palate bone, bounded exteriorly by the upper maxillary, is the posterior palatine foramen. About one or two lines behind this is another foramen, in the base of the pterygoid process of the palate bone, through which pass fibrillæ, of the same nerve that occupies the posterior palatine foramen. The posterior palatine foramen also transmits an artery to the soft palate, the mark of whose course may be seen at the base of the alveolar processes for the molar teeth.

The internal surface of the lower jaw has been sufficiently described in the account of that bone.

The depth of the palatine fossa depends on the state of the teeth.

When they are removed by old age, and the alveolar processes also, what was palatine fossa of the upper maxilla is almost a plain surface; and in many instances of extreme old age the palatine fossa is wholly obliterated, excepting the part formed by the remains of the lower jaw. The separation from the nose is also extremely thin, and not unfrequently imperfect. The transverse diameter of the mouth is much decreased in consequence of the absorption of the alveolar processes taking place, from their outside towards the inside.

The guttural region of the base of the head is formed by the cuneiform process of the os occipitis, in the centre; by the inferior face of the petrous bones, laterally and behind; by the body and spinous process of the sphenoid bone, in front and laterally; and by the several bones contributing to the orifice of the posterior nares.

It is bounded anteriorly by the pterygoid fossæ and the openings of the nose, and behind by the mastoid processes and by the condyles of the os occipitis. It consists, consequently, in one part, which is horizontal, and in another which is vertical. In regard to the horizontal portion, its inequalities, processes, and fossæ have been already stated. The relative position of its foramina cannot, however, be studied except in the united bone. The following rules will afford some assistance in determining their position even on the living body.

A line passing from the anterior margin near the base of one mastoid process to the corresponding part of the other, will subtend the stylo-mastoid foramina and the posterior margin of the foramina lacera; it will also touch the base of the styloid processes and the condyles of the occiput. A line, three-eighths of an inch in advance of this, run through the middle of the meatus auditorius externus, will indicate the posterior margins of the glenoid cavities,[1] intersect the inferior end of the carotid canals or foramina, and the anterior margins of the anterior condyloid foramina. Another line, one-fourth of an inch in advance of the latter, will cut through the centre of the glenoid cavity, and subtend the styloid process of the sphenoid bone and the bony orifice of the Eustachian tube in the temporal bone. A line passing between the external ends of the tubercles of the temporal bones will subtend the foramina ovalia and the foramina lacera anteriora. The foramen spinale is about equi-distant from the last two lines.

The foramen lacerum anterius, being at the point of the petrous bone, is occasioned by the latter not filling up the space between itself and the sphenoidal and the occipital bone. The deficiency is supplied, in the recent state, by cartilage. Precisely opposite to the point of the petrous bone is the posterior orifice of the foramen pterygoideum, from which emerges the pterygoid nerve, and penetrating this cartilage immediately divides into two branches; that going to the carotid canal becomes one of the roots of the sympathetic nerve, and the other, ascending into the cranium, becomes the Vidian nerve or superficial petrous.

The vertical portion of the guttural region presents the posterior orifices of the nostrils, separated from each other by the vomer. On

[1] By glenoid cavity in this paragraph is meant the whole of the depression in the temporal bone, and not merely the surface for the condyle of the lower jaw.

each side are the pterygoid processes of the sphenoid bone, and above, is its body. The pterygoid fossa, formed between the external and internal process, and the long unciform termination of the latter with the broader and shorter termination of the former, will also be observed.

The Occipital region of the base of the head, placed immediately behind the other, may be considered to include the mastoid processes, and the foramen magnum occipitis, and to be bounded behind by the tuber of the occiput and its superior transverse ridges. Its marks have been sufficiently dwelt upon, in the description of the os occipitis.

The third oval will be described in detail in a short time.

On the side of the head, where we consider the triangular region to exist, the arch formed by the malar bone and the zygomatic process of the temporal, constitutes a very conspicuous feature. The anterior abutment of this arch is formed by the greater part of the malar bone, and a considerable portion of the malar process of the superior maxillary. The posterior abutment is formed by the root of the zygomatic process of the temporal bone. Its superior margin is thin, for the insertion of the temporal aponeurosis: the inferior margin is thick, and is divided, by a projection in its middle, into an anterior and a posterior surface, marking the origins of the two portions of the masseter muscle. There is a very considerable vacancy between the zygoma and the side of the head, occupied by the coronoid process of the lower jaw, the temporal and the external pterygoid muscles. The coronoid process is just within the zygomatic arch, and its tip rises three or four lines above its inferior margin.

The large depression within the zygoma is the temporal fossa. All that portion of the side of the head, beneath the ridge called parietal, leading from the external angular process of the os frontis, and running along the surface of the parietal bone, is tributary to the temporal fossa. The bones, therefore, which contribute to form it, are the frontal, the parietal, the temporal, the great wing and the external pterygoid process of the sphenoid bone, and the posterior face of the superior maxillary and malar bones. The arrangement of the squamous suture is well seen in this fossa, also the junction of the pterygoid bone with the parietal and frontal, by the overlapping of the great wing of the former. At the inferior part of the latter, is the pointed process, from which one head of the external pterygoid muscle arises.

At the bottom of the temporal fossa there is a narrow slit partitioned from the nose by the nasal plate of the palate bone. This slit, from its position between the pterygoid process of the sphenoid and the upper maxillary, is called the Pterygo-maxillary fossa. It is triangular, the base being upwards and the point downwards. The base reaches to the bottom of the orbit. From the base there leads into the nose the spheno-palatine foramen for transmitting the lateral nasal nerve and blood-vessels. Externally to this foramen, and somewhat above it, is the foramen rotundum for the upper maxillary nerve. On a level with the spheno-palatine foramen, and running horizontally through the base of the pterygoid process, is the pterygoid foramen for the nerve of the

same name. Running vertically downwards from the point of the pterygo-maxillary fossa, is the posterior palatine canal for transmitting the nerve and artery of the same name. The upper part or base of the pterygo-maxillary fossa is continuous with a large fissure in the bottom of the orbit called the Spheno-maxillary.

SECT. V.—OF THE NASAL CAVITIES.

The nose consists of two large cavities or fossæ, in the middle of the bones of the upper jaw, and has a very irregular surface. Its cavities are separated from one another by a vertical septum, consisting of the vomer and of the nasal lamella of the ethmoid bone. This septum presents a surface which is perfectly plain, with the exception that in some subjects it is slightly convex on one side, and concave on the other. It is deficient in front.

The upper part of either nostril is formed by the cribriform plate of the ethmoid bone: in front of this the surface is very oblique, being made by the ossa nasi; posteriorly there is a vertical gutter on the body of the sphenoid bone, in the middle of which is the orifice of the sphenoidal cell. The distance between the cellular part of the ethmoid and the septum nasi is not more than three lines. The double row of foramina in the cribriform plate is very well seen, also the foramen at its anterior part for transmitting the nasal branch of the ophthalmic nerve; the groove formed by the latter on the posterior face of the ossa nasi is also very distinct.

The bottom of either nostril, called its floor, is formed by the palate process of the superior maxillary and palate bones; it is somewhat concave, and about half an inch wide; its width, however, is not uniform, as it is sometimes wider or narrower in front than it is in the middle. In it is seen the upper orifice of the foramen incisivum, at the anterior point of the vomer.

The external or orbitar surface of the nasal cavity is very irregular, presenting a number of projections and fossæ, over which the Schneiderian membrane is displayed. It is formed by the upper maxillary, the ethmoid, the unguiform, the palate, the nasal, the lower spongy, and the sphenoid bones. In the middle of the posterior part of the ethmoid is the upper meatus of the nose, a deep fossa, bounded above by the cornet of Morgagni, or the superior turbinated bone, and receiving the contents of the posterior ethmoidal cells, by one or more orifices. At the posterior termination of this fossa is the spheno-palatine foramen. The middle spongy bone forms the lower boundary of the ethmoid; between it and the lower spongy or turbinated bone, is the middle meatus of the nose, a fossa of considerable size, but of unequal surface. At the fore part of the middle meatus is a vertical projection, formed by the ductus ad nasum and lachrymal fossa. Just behind this ridge, is an interval between it and the anterior part of the ethmoid, through which the os unguis may be seen. When the middle spongy bone is broken off, immediately beneath its anterior part, a channel obliquely vertical is seen in the ethmoid, which leads to the frontal sinus, through the anterior ethmoidal cell. This cell, from its peculiar shape and func-

tion, is called infundibulum. Behind this oblique channel is another oblique channel, parallel, but smaller; in which several orifices may be found of the anterior ethmoidal cells. The anterior channel has, indeed, for the ethmoidal cells, other orifices besides the infundibulum, which are smaller, and below the latter. It is bounded in front by a sharp, thin ridge of the ethmoid, the lower extremity of which contributes to close the large opening into the sinus maxillare.

Commonly, about the middle of the middle meatus of the nose, but varying very much in different subjects, is the orifice of the sinus maxillare, or antrum Highmorianum. Its precise situation and direction are so very uncertain, that its orifice is found with some difficulty in the fresh state, in a great number of persons. Not unfrequently I have seen this orifice high up, under the anterior extremity of the middle spongy bone.

The inferior meatus of the nose is bounded above by the lower spongy bone, and below by the palate processes. It extends the whole length of the nostril. At the anterior part of this meatus above, is the orifice of the ductus ad nasum, which communicates with the orbit of the eye.

The nostril presents an increased width, anterior to the points, where the spongy bones cease: this space is bounded on the orbitar side by the nasal bone, and the nasal process of the upper maxillare. There is an increase of transverse diameter also at the posterior part of the nostril, behind the points where the spongy or turbinated bones cease. This space is bounded externally by the nasal plate of the palate bone, and by the internal pterygoid process.

The posterior nares, or orifices of the nostrils, are oval, and are completely separated by the posterior margin of the vomer. In the dried skeleton, on the contrary, the anterior nares have a common orifice, from the deficiency of the bony septum between them.

SECT. VI.—ORBITS OF THE EYES.

The orbits of the eyes are the conoidal cavities in the face, presenting their bases outwards and forwards, and their apices backwards; so that the diameter of either orbit, if continued, would decussate that of its fellow in the pituitary fossa or sella turcica. Seven bones concur in forming the orbit, to wit, the os frontis, the os malæ, the os maxillare superius, the os planum, the os unguis, the os sphenoides, and the os palati. Its cavity is somewhat quadrangular, besides being conoidal. The angles are particularly well marked, in most subjects, at its base or orifice, which resembles an oblong, having its long diameter in some persons placed almost horizontally, and in others obliquely downwards and outwards. Immediately within the orifice the cavity is enlarged, behind the projection of the orbitary ridge of the os frontis, and the elevation of the anterior inferior margin of the orbit, so that the greatest diameter is there rather vertical than horizontal. From this point the orbit decreases gradually in size to the sphenoidal fissure, or the superior foramen lacerum of the orbit which forms its apex. The internal walls of the two orbits are nearly parallel, in consequence

of the cuboidal figure of the os ethmoides, which is placed between them.

The superior face or roof of the orbit is triangular and concave: it is very thin, and presents but a slight septum between the eye and the brain. Almost the whole of it is formed by the orbitar process of the os frontis, its point only being made by the little sphenoidal wing. The depression for the lachrymal gland, at its external anterior part, is very perceptible. The trochlea, for the superior oblique muscle of the eye, is also well seen about six or eight lines above the point of the internal angular process of the os frontis. Just at the outer side of this depression is the foramen or notch for the supra-orbitar artery and nerve. The optic foramen may be seen, very readily, passing through the little wing of the sphenoid bone.

The inferior face, or the floor of the orbit, is also triangular and concave, and is formed principally by the orbitar process of the upper maxillary bone; being assisted, however, at its anterior external margin, by a portion of the malar bone, and, at its point behind, by the orbitar process of the palate bone. The latter cannot be seen very distinctly in the articulated bones, owing to its great depth in the orbit; but, when the external side of the orbit is removed with a saw, its position is placed in an interesting light. The floor of the orbit is thinner than its roof, and forms a very slight separation from the maxillary sinus. It is terminated behind by the spheno-maxillary fissure, or inferior foramen lacerum of the orbit; a large slit, which, commencing at the base of the sphenoidal fissure, separates the great wing of the sphenoidal bone from the ethmoidal, the palate, and the upper maxillary bones. This fissure runs obliquely outwards, so as to have its external extremity terminated by the malar bone. Near the external extremity is seen the commencement of the infra-orbitar canal, for transmitting the infra-orbitar nerve and artery.

The external face of the orbit is also triangular, and very oblique. It is formed by the malar bone, and by the orbitar face of the great sphenoidal wing. It is defined below by the spheno-maxillary fissure, and above by the suture which unites the frontal to the malar, and to the great wing of the sphenoidal bone. It is terminated, at the apex of the orbit, by the sphenoidal fissure.

The internal face of the orbit is an oblong square, nearly parallel, as mentioned, with the corresponding face of the other orbit. It is formed principally by the orbitar face of the ethmoid, called the os planum; but at the apex of the orbit a small portion of the body of the sphenoid bone contributes to it, and anteriorly is the os unguis. It is bounded behind by the sphenoidal fissure, in front by the lachrymal ridge (*crista lachrymalis*) on the nasal process of the os maxillare superius, and above and below by the upper and lower ethmoidal sutures. In the upper of these sutures there are generally two, but sometimes three orbital, or ethmoidal foramina; the anterior of which transmits the anterior ethmoidal artery and vein, and the internal nasal nerve, to the nose; the posterior transmits the posterior ethmoidal artery and vein to the same.

The lachrymal fossa is well worthy of attention: it is seen to commence small at the upper part of the os unguis, and to increase in size till it is formed by the upper maxillary and the inferior spongy bones into a complete canal, the ductus ad nasum, leading to the nose. The direction of the canal is almost vertically downwards, inclining very slightly backwards. It was stated, that the fossa in the fore part of the os unguis is sometimes supplanted by the increased breadth of the nasal process, a fact of some importance to an operator for fistula lachrymalis.

SECT. VII.—OF THE FACE, TOGETHER WITH SOME REMARKS ON THE FACIAL ANGLE, AND ON NATIONAL PECULIARITIES.

The anterior oval of the head extends from the frontal protuberances to the base of the lower jaw, and from the malar bone of one side to the malar of the other inclusively. This oval is divided into two symmetrical or equal halves, by the vertical suture, which unites the bones of the opposite sides of the face.

In the infant, the frontal protuberances are always well marked, from their being the centres of ossification for the two halves of the os frontis; in the adult, they are frequently not raised above the common level of the bone. The superciliary protuberances just above the internal half of the orbitary or superciliary ridges are generally somewhat prominent, but they vary very much in this respect in different individuals. Between these ridges the frontal bone is sometimes raised into a vertical elevation (*crista frontalis externa*), continuous with the dorsum of the nose, as is more frequently seen in young persons.

The nose, or pyramidal convexity, formed by the nasal processes, of the superior maxillary, and by the nasal bones, is concave above, and extremely prominent below. The prominence of it depends upon the development of the ossa nasi. I have frequently seen the latter curtailed to about one-half, and even one-third of their usual breadth, and also diminished in length, which is followed by an unusual flatness of the nose: the peculiarity had been presented to me for a considerable time only in negroes, but, since then, I have also met with it in the skulls of white subjects: it is, however, much more uncommon in the latter. The anterior orifice of the nose is cordiform, the base being below: the centre of the base is marked by a rough point, called the anterior nasal spine.

In skulls generally the inferior margin of the anterior bony naris is in the condition of a sharp semicircular edge, but it has been remarked lately[1] that in the head of the African, this edge is generally fluted, the fluting beginning narrow externally and augmenting in breadth as it advances to the anterior nasal spine. The author of this observation considers this fluted edge as the invariable and exclusive characteristic of the African head; a comparison, however, will show that it occasion-

[1] By Mr. Robert Frame, of New York, a preparer of Anatomical Pieces.

ally exists also in the Caucasian head, but it is by no means comparable in frequency of occurrence.

The cheek bones form on either side of the face a considerable prominence, depending much upon the length of the malar process of the upper maxillary bones. In savage tribes, this prominence is frequently a characteristic trait, and may depend upon the greater development of the upper maxillary sinuses. The elevation of the cheek bone is always conspicuous in emaciated subjects, from the fat around its base being absorbed.

The alveolar processes with the teeth produce, in certain subjects, a very prominent projection in the face, varying, however, considerably in different individuals, and in different tribes of human beings. There is but little doubt of the organization of some men being more coarse and animal than that of others, even in members of the same family. The circumstance occasionally manifests itself by unusually large and long teeth, and by alveolar processes of corresponding dimensions. Savage nations have almost invariably this peculiarity, which is kept up among them, not only by hereditary influence from father to son, but also by the actual habits of the individual being productive of, and favorable to this arrangement. It would be interesting to know how far articles of food hard to masticate contribute to, or even produce, a greater development in the organs of mastication. Analogy is in favor of the opinion, because the arms or the legs are always developed in proportion to the vigor and frequency of the exercise to which they are put. Ploughmen have large legs. Blacksmiths have large arms. Persons whose habits of exercise do not call into action any part of the body, to the exclusion of other parts, have finer and more graceful forms than laborers. It is, therefore, probable that the ease and gracefulness of movement, said to mark the polished and accomplished man of fashion, depend upon the harmonious action of his whole frame, derived from this proportionate development of all its parts. Besides the influence of exercise upon the organs of mastication, the passions or faculties of the mind not unfrequently manifest themselves there. Individuals of unusual ferocity and savageness have frequently large teeth and alveolar processes. The gnashing of the teeth has, in all ages, been considered one of the most striking signs of anger.

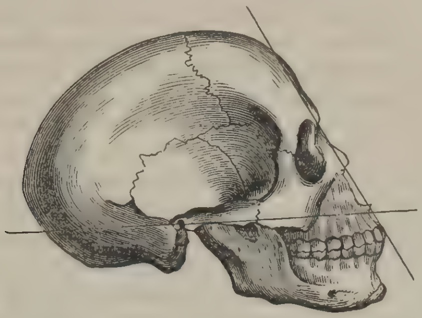
While speaking of these indications of man in a savage and uncultivated state, it will be understood that I allude to such tribes as are engaged in the chase, and in other active modes of subsistence, and whose habits are not settled down into the agricultural or pastoral condition. It is quite possible for one in the latter situation to be equally uninstructed, on every point of mental improvement, and to be much inferior in capacity to one of the former; yet his articles of food, and the sensations and passions in which he indulges, will give no very prominent outline to his face, but only stamp it with the general expression of dullness and ignorance.

The outline of the face is marked also by depressions or fossæ. Those for the eyes and for the nose have been studied, and arrest at once the attention of the most superficial inquirer. Immediately below the orbit

is the canine fossa formed in the centre of the front of the upper maxillary bone. Just above the incisor teeth of this bone is the superior incisive fossa. Below the inferior incisor teeth, on each side also, is the inferior incisive fossa.

In most adults the face projects somewhat beyond the cranium, but there is a considerable diversity in this respect between different tribes of human beings. Camper,[1] who has paid much attention to this arrangement, has designated it under the term of the *facial angle*,

Fig. 52.



A lateral view of the Skull, showing the lines and direction of the facial angle.

which he marks off by two straight lines. One is drawn from the lower front part of the frontal bone to the point called the anterior nasal spine at the orifice of the nose, terminating between the ends of the roots of the incisor teeth of the upper jaw; the other, from this latter point to the middle of the meatus auditorius externus, or thereabouts. The facial angle is included between these two lines. In Caucasian, or European heads, this angle is about eighty degrees; in the negro, or Ethiopian, it is about seventy degrees; and in the Mongolian or copper-colored man, about seventy-five degrees.

An invariable relation is established between the degrees of the facial angle, the capaciousness of the cranium, and the size of the nasal and of the palatine regions. The nearer the approach is to a rectangle, the smaller is the cavity of the nose, and of the mouth, and the greater is that of the cranium, thereby declaring a more voluminous and intellectual brain. On the contrary, the more acute that the facial angle is, the smaller is the volume of brain, and the larger are the nose and mouth. This is so frequently the case, that Bichat considers it almost a rule in our organization, that the development of the organs of taste and smell is in an inverse ratio to that of the brain, and consequently to the degree of intelligence.

This, like other general rules, is subject to exceptions, in consequence of the facial angle varying in its size, from causes which have no connection with the degree of development of the brain. Thus an unusual prominence and thickness in the lower part of the os frontis, from an increased capaciousness of the sinuses, will make the facial angle

[1] Dissertation sur les Différences du Visage chez les Hommes, Utrecht, 1791.

appear less acute. The wasting of the alveolar processes, after the loss of the teeth, will produce the same result in our measurements of the facial angle. The heads of infants, previously to the appearance and full growth of the teeth, have always the facial angle less acute than the heads of adults: in some cases an angle of ninety degrees is presented in them. On the contrary, a growth of teeth, and consequently of the alveolar processes, disproportionate to the size of the body of the upper jaw, will cause the facial angle to project very considerably even in an individual of the Caucasian race. Objections may also be brought against the indications of the inferior line. The fair state of this argument appears to be that the doctrine of the facial angle, though correct in a majority of instances, has numerous exceptions from individual peculiarities, and that there is no race of human beings which does not present the facial angle in all its ranges, from seventy to ninety degrees.

With the view to meet such objections, and establish a rule of more uniformity, M. Cuvier has proposed to ascertain results from a vertical section in the middle of the head, by which it appears that the Caucasian cranium is four times the area of the face; whereas in the negro the face is a fifth larger than the Caucasian face by the same rule of measurement.

In regard to the various configurations of the human face and stature, depending upon habits and circumstances continued through a long succession of ages and generations, the following views of one* who was pre-eminently qualified to judge, and of the highest authority, will not be uninstructive.

"Although there appears to be but one human species, since all its individuals can couple promiscuously, so as to produce a prolific offspring, we yet remark in it certain hereditary conformations, which constitute what are called *races*. Of these there are three which are eminently distinct in appearance: they are the white or Caucasian; yellow or Mongolian; the negro or Ethiopian.

"The Caucasian race, to which we belong, is distinguished by the beautiful oval form of the head; and it is this which has given birth to the most civilized nations, and to those which have generally ruled over the others. It has some differences in the shade of the complexion, and in the color of the hair."

"The Mongolian is known by its prominent cheek bones, flat face, narrow and oblique eyes, straight and black hair, thin beard, and olive complexion. It has formed vast empires in China and Japan, and has sometimes extended its conquests on this side of the Great Desert; but its civilization has always remained stationary."

"The Negro race is confined to the south of Mount Atlas; its complexion is black, its hair woolly, its skull compressed, nose flattish; its prominent mouth and thick lips make it manifestly approach the

* Règne Animal, par M. le Chev. Cuvier, tom i. p. 94, Paris, 1817.

monkey tribe; the people which compose this race have always remained in a state of barbarism.

"The race from which we are descended is called Caucasian, because tradition, and also the lineage of nations, would appear to trace it to the group of mountains situated between the Caspian and the Black Sea (on the borders of Europe), from whence it has radiated in every direction. The people of Caucasus, as also the Georgians and Circassians, are considered, even at the present day, the handsomest in the world. The principal branches of this race are distinguishable by the analogies of language. The Armenian or Syrian division directed its course towards the south, and has given birth to the Assyrians, the Chaldeans, and the untameable Arabs, who, after Mahomet, were very near becoming masters of the world; to the Phenicians, the Jews, and the Abyssinians, which were Arabian colonies; and it is very probable that the Egyptians also are descended from the same source. It is from this branch (the Syrian), always inclined to mysticism, that the most widely-extended religions have sprung. Science and literature have flourished among them occasionally, but always under fantastic forms, and with a figurative style.

"The Indian, German, and Pelasgic branch is infinitely more extended, and was divided at a much earlier period; we, nevertheless, recognize the greatest resemblance between its four principal languages; which are, the Sanscrit, at present the sacred language of the Hindoos, and mother of all the dialects of Hindostan; the ancient language of the Pelasgi, which is the common mother of the Greek, the Latin, of many tongues which are now extinct, and of almost every language spoken in the south of Europe; the Gothic or Teutonic, from which are derived the languages of the North and North West, such as the German, Dutch, English, Danish, Swedish, and their dialects; and lastly, the language called Sclavonian, from which come those of the north-east, as the Russian, Polish, Bohemian, &c.

"It is this great and respectable branch of the Caucasian race which has carried farthest Philosophy, the Arts and Sciences, and which has been for ages the depository of them.

"This branch was preceded in Europe by the Celts, who came from the north, and were formerly very much extended, but are now confined to the most western parts; and by the Cantabrians, who passed from Africa into Spain, and are, at present, almost confounded with the numerous nations whose posterity has been blended in this peninsula.

"The ancient Persians have the same origin with the Indian branch; and their descendants, even at the present day, bear the strongest marks of affinity to the European nations.

"The Scythian or Tartarian branch, first directing their course to the north and north-east, always led erratic lives in the vast plains of those countries; and they have only left them to return and destroy the more comfortable establishments of their brethren. The Scythians, who, at so remote a period of antiquity, made irruptions into Upper Asia; the Parthians, who destroyed there the power of the Greeks and Romans; the Turks, who overthrew there that of the Arabs, and subjugated in Europe the unhappy remnant of the Greek nation, were

swarms of this stock; the Finlanders and the Hungarians are colonies of it, in some measure astray among the Sclavonian and Teutonic nations. The north and east of the Caspian Sea, their original country, are still inhabited by people of the same origin, and speaking similar languages; but they are there intermixed with an infinity of other petty nations, of different origins and languages. The Tartar nation has always remained more unmixed in all that tract of country, extending from the mouth of the Danube to beyond the Irtisch, from which they so long threatened Russia, and where they have at last been subdued by her. The Mongolians, however, in *their* conquests, have blended their blood with these people, and many traces of this intermixture are discovered, principally among the Western Tartars."

"The Mongolian race commences to the east of this Tartar branch of the Caucasian, and prevails thence to the Eastern Ocean. Its branches, the Calmucks and Halkas, still nomadic or unsettled, occupy the Great Desert. Thence have their ancestors, under Attila, under Genghis, and under Tamerlane, spread far and wide the terror of their name. The Chinese come from this race, and are not only the most anciently civilized of it, but, indeed, of any nation yet known. A third branch (the Montchoux) has recently conquered China, and continues to govern it. The Japanese and Coreans, and almost all the hordes which extend to the north-east of Siberia, under the domination of Russia, belong also to it in a great measure. If we except a few Chinese literati, the whole Mongolian race is universally addicted to the different sects of the worship of Fo.

"The origin of this great race appears to have been in the Altay Mountains,[1] as ours was in the Caucasian; but it is impossible to follow so well the clue of its different branches. The history of these wandering people is as fugitive as their establishments; and the records of the Chinese, from being confined to their own empire, afford us but short and vague accounts of the neighboring nations. The affinities of their languages are also but too little known to guide through this labyrinth.

"The languages of the north of the peninsula beyond the Ganges, and also that of Thibet, bear some affinity to the Chinese, at least in their monosyllabic nature, and the people who speak them are not without traits of resemblance to the other Mongolian nations; but the south of this peninsula is inhabited by the Malays, a much handsomer people, whose race and language are spread over the coasts of all the islands of the Indian Archipelago, and have occupied almost all those of the Southern Ocean. On the largest of the former, especially in the uncultivated and savage parts, we find other men, who have woolly hair, black complexion, and negro visage, and who are all extremely barbarous. The most known are the Papuas, a name by which they may be generally denominated.

"It is not easy to refer either the Malays or Papuas to any one of the three great races; but can the former be plainly distinguished from their neighbors, the Caucasian Hindoos on one side, and the Mongolian

[1] A range in the north of Asia, about 5000 miles long.

Chinese on the other? We must confess that we do not find them to possess sufficient characteristics to enable us to answer this question. Are the Papuas negroes, who formerly straggled along the Indian Ocean? We have neither drawings nor descriptions sufficiently clear to reply to this question.

"The inhabitants of the north of the two continents, the Samoiëdes, the Laplanders, and the Esquimaux, sprung, according to some authorities, from the Mongolian race. Agreeably to others, they are but a degenerate offspring of the Scythian and Tartarian branches of the Caucasian race.

"It is impossible to refer, satisfactorily, the Americans themselves to either of our races of the old continent; and yet they have not characteristics precise and constant enough to constitute a distinct race. Their copper-colored complexion is not sufficient; their hair, which is generally black, and their scanty beard, would lead us to refer them to the Mongolians, did not their well-marked features, and their moderately prominent noses, oppose such an arrangement; their languages are as innumerable as their tribes, and we have yet been unable to discover either any analogies among them, or with those of the ancient world."[1]

SECT. VIII.—OF THE DEVELOPMENT OF THE FŒTAL HEAD.

The fœtal head, in very early stages of gestation, forms an oval vesicle, constituting the greater part of the bulk of the embryo, and at this period has the face scarcely visible. The parietes of this vesicle are formed by a thin membrane, consisting of two layers, the external of which is the pericranium, and the internal layer is the dura mater. These layers adhere so closely, that they cannot be accurately separated by the knife.

About the third month of the embryo, or even earlier, ossification may be seen at several points of the cranium, but more extensively about its base. These points are the centres of ossification, which progressively increase towards their respective circumferences, by the deposit of new bony matter. Generally the base of the cranium begins to ossify before the vault, and is entirely ossified at birth, with the exception of a few parts, as the clinoid processes and the ethmoid bone.

The following nuclei of ossification show themselves between the laminæ of the fœtal cranium, from the third to the fourth month. One at the anterior part, for the centre of either side of the os frontis; one for the centre of each parietal bone, on the upper side of the head; one on the side of the head below, for the squamous portion of the temporal bone; and there are several for the occipital bone. These

[1] On this subject, see also Lectures on the Physiology, Zoology, and Natural History of Man, by W. Lawrence. London, 1822.
Dictionnaire des Sciences Méd. tome xxi. Paris, 1817.
Histoire Naturelle de L'Homme, par Lacepede. Paris, 1821.
Blumenbach de Variet. Gen. Hum. Nat. 1794—also Decades, 1790—1814.

points extend themselves in radii; and, as the intervals between the latter become wider by their divergence, new radii, as observed elsewhere, are deposited between them. In some of the bones, the radii, from opposite points, in the progress of ossification before and after birth, meet and coalesce: this occurs in the os frontis and in the os occipitis.

At birth the contiguous margins of the flat bones simply approach each other, but have not interlocked. These bones consist then of but one table, the edges of which are very finely serrated, and thereby show the radii of ossification. The edges are held together by the dura mater, internally, and the pericranium, externally, but the fissure between them is very obvious, and so large that it allows very readily considerable motion and the mounting of one bone upon the other by slight pressure. It is always to be observed that the base of the cranium is an exception to the latter rule, both from the breadth of its articulating surfaces, and from its comparatively advanced ossification. In parturition, therefore, the vault of the cranium, by its mobility, is adjusted to the contour of the pelvis, but the base does not yield in either of its diameters to the expulsive powers of the uterus. The latter provision, however inconvenient in parturition, is of the greatest consequence immediately afterwards; for without this immobility in the base of the cranium, whenever the weight of the head was thrown upon it, the pressure of the vertebral column would drive it upwards, to the injury of the brain and of the nerves proceeding from it. This resistance, it may be added, is still farther assisted by the arched figure of the base of the cranium. On this subject, it is not a little remarkable, that even the heads of the hydrocephalic fœtuses have the bones of the base fully ossified, and in contact, so as to support the weight of the head in the vertical position.

Fontanels.—In consequence of the flat bones of the cranium ossifying always towards the circumference, their angles, as observed, being the longest radii from their centres, are the last in ossifying. These angles

Fig. 53.

A view of the Fœtal Head, showing the Fontanels.—1. Posterior fontanel. 2. Line of separation of the parietal bones. 3. Anterior fontanel. 4. Line of separation of the os frontis. 5, 5. Coronal suture.

are commonly incomplete at birth, and the membranous spaces which represent them are the Fontanels. Of these there are six, two on the middle line of the head, above, and two on either side. The former afford highly important indications to the accoucheur.

The anterior fontanel is the largest of all. It is at the fore part of the sagittal suture, and is produced by a deficiency in the angles of the parietal bones, and of the contiguous angles of the os frontis. It is quadrangular or lozenge-shaped, and the anterior angle is generally longer than the others. This is remarkably the case, when the sagittal suture is continued down to the root of the nose. The posterior fontanel is at the other extremity of the sagittal suture, and as there are only three points of bone defective there, two for the parietal bones, and one for the occipital, this suture is triangular. In many children, at birth, it is so far filled up as to be scarcely visible; the three membranous sutures, however, which run into it, make its position sufficiently discernible by the finger.

Of the two fontanels, on either side, one is placed at the angle of the temporal bone, where it runs up between the occipital and the parietal. The other is in the temporal fossa, under the temporal muscle, at the junction between the parietal and the sphenoidal bones. These two fontanels are but little referred to by the accoucheur in delivery, as they are irregular and indistinct. The pulsations of the brain may be readily felt through the fontanels. They ossify rapidly after birth, and are frequently closed completely by the end of the first year; but if there be an accumulation of water in the ventricles of the brain, they remain open for an indefinite period.

The longest diameter of a child's head is from the vertex or posterior extremity of the sagittal suture to the chin, and measures five inches and a quarter. From the middle of the frontal bone to the tubercle of the occipital is four inches; from one parietal protuberance to the other, is about three inches and a-half.

At birth the os frontis consists, most commonly, of two pieces, united by the sagittal suture. The parietal bone is a single piece, incomplete at its angles. The temporal bone consists of three pieces: one is the squamous, the other is the petrous, and the third is a small ring which afterwards constitutes the meatus externus; it is deficient in styloid and mastoid processes. The os occipitis is in four pieces: one extends from the angle of the lambdoidal suture to the upper edge of the foramen magnum; on either side of the foramen magnum is another, with the condyle growing on it, and the cuneiform process is the fourth. The ethmoid bone is cartilaginous. The sphenoidal bone is in three pieces. The body and little wings, being united, form one; the great wing and the pterygoid process, being also united, form on either side of the body another piece.

At birth there is a great disproportion in size between the cranium and face. This disproportion diminishes in the progress of life, by the development of the sinuses and of the alveolar processes in the latter. At birth, indeed, there is no cavity either in the sphenoidal, the frontal, or the upper maxillary bones; the orbitar and the palate plates are very near each other, and the rudiments of the teeth are hidden in the bodies of the upper and lower jaw bone. The latter consists of two pieces, united by cartilage at the chin, and its angle is very obtuse.

CHAPTER IV.

THE HYOID BONE (OS HYOIDES, HYOIDE).

The Os Hyoides is placed at the root of the tongue, within the circle of the lower jaw. It is an insulated bone, having no connection with any other, except by muscles and ligaments. It is said, very properly, to resemble the letter U, and consists of a body and of two cornua.

The body is in the middle; it is the largest part of the bone, and forms nearly a semicircle. Its anterior face is convex, and its upper part is flattened by the insertion of the muscles from the lower jaw, as the genio-hyoideus and the genio-hyoglossus. The posterior face is concave, for adjusting it to the superior margin of the thyroid cartilage.

The cornua, one on either side, are about an inch long, and are placed at the extremities of the body, being united to it by the interposition of cartilage and ligamentous fibres. They are flattened above and below rather than cylindrical, and diminish towards the posterior extremities, where they terminate in a round enlargement, like a head.

Fig. 54.

An anterior view of the Os Hyoides.—1. The anterior convex side of the body. 2. The cornu majus of the left side. 3. The cornu minus of the same side. The cornua majora were ossified to the body of the bone, in this specimen.

At the fibro-cartilaginous junction of the cornu and body, on each side, there is a small cartilaginous body three or four lines long, fastened by ligamentous fibres. It is frequently found ossified. This is the appendix or lesser cornu.

A round ligament, the *stylo-hyoid*, passes to it from the inferior extremity of the styloid process of the temporal bone. Sometimes the ossification of the appendix extends along the substance of this ligament for half an inch or an inch, but it is generally flexible at the root, and on rare occasions ossification of the ligament is so extensive, as to produce serious difficulty in talking and swallowing, by its reaching to the styloid process.

The texture of this bone is cellular, with a thin compact lamina externally. M. Portal says, that he has found it carious from venereal contamination; in which case, the patient had been afflicted with violent sore throat and purulent expectoration. Sauvages and Valsalva have each met with a case, where, from luxation of the cornu, the patient spoke with great difficulty.

CHAPTER V.

OF THE UPPER EXTREMITIES.

This portion of the skeleton is divided on either side of the body, into shoulder, arm, forearm, and hand. The bones are the clavicle, scapula, os humeri, ulna, radius, those of the carpus, the metacarpus, and the phalanges.

SECT. I.—OF THE SHOULDER.

The shoulder consists of the two bones, the clavicle and the scapula, and occupies the superior, lateral, and posterior part of the thorax. Its shape and position are such, that it augments considerably the transverse diameter of the upper part of the trunk, taken as a whole: while the thorax alone, at this place, is actually smaller than it is below. The clavicle is longer, in proportion, in the female than in the male, which increases in her the transverse extent of the shoulder, and gives a greater space on the front of the thorax for the development of the mammæ. This coincidence between the length of the shoulder and the development of the mamma has been particularly noticed by Bichat, who says that it is almost always well marked, that very rarely a voluminous bosom reposes on a small pectoral space, or a small bosom is found upon a large pectoral space. In the male, on the contrary, this diameter of the trunk is increased principally by the breadth of the scapula, which, from its position on the thorax, and its great size, gives the bulky appearance to this part. It is evident that these modifications in the framework of the shoulders are connected with the natural destinations of the two sexes. In woman the length of the clavicle is adverse to its strength, and it is indistinctly marked by muscular connections; whereas, in man it is short, strongly marked, and large. Anatomists who are fond of extending such comparisons, say, also, very justly, that the pubes, which perform the same office for the lower extremities that the clavicles do for the upper, that of keeping the two apart, are, in the female, both smaller and longer than in the male; that their shape is not so favorable to strength or locomotion, and has a special view towards the lodgment of the genital organs, and to the passage of the child. In man the increased size of the whole skeleton, and the greater development of the muscular system, indicate that he was intended for more laborious exertion than the female.

The thorax and the shoulder are connected by a reciprocal development, both being, when large, indicative of a robust and vigorous constitution; and when small, of a weakly one. As both of these parts are acted on by the same muscles, the necessity of this coincidence is sufficiently apparent. The height of the shoulder depends upon the

scapula alone; its elevation, therefore, is greater in males and in vigorous persons generally, than in females and in weakly individuals. The direction of the shoulder is such, that the articular face of the scapula for the os humeri looks outwards, thereby proving that the quadruped position in man is unnatural; for by this direction, the weight of the fore part of the trunk is directed upon the back part of the capsular ligament of the joint instead of upon the glenoid cavity, as in quadrupeds. This, and many other circumstances, prove that the natural intention of the upper extremities in the human subject is to seize upon objects, and not to maintain the horizontal position.

Of the Shoulder Blade (Scapula, Omoplate).

The Scapula is placed upon the posterior superior part of the thorax, and extends from the second to the seventh rib inclusively; its posterior edge is nearly parallel with the spinous processes of the vertebræ, and not far from them.

Its general form is triangular. It therefore presents two faces, of which one is anterior, and the other posterior; three edges, of which one is superior, another external, and the third internal or posterior; and three angles, of which one is superior, another inferior, and the third exterior or anterior.

The posterior face of the scapula is called its *dorsum;* is somewhat convex, when taken as a whole; and is unequally divided by its spine into two surfaces or cavities, of which the lower is twice or three times as large as the upper. The spine is a very large process that begins at

Fig. 55.

A posterior view of the Scapula of the left side. 1. Fossa supra-spinata. 2. Fossa infra-spinata. 3. Superior costa. 4. Coracoid notch. 5. Inferior costa. 6. Glenoid cavity 7. Inferior angle. 8. The neck and point of origin of the long head of the triceps muscle. 9. Posterior margin, or base. 10. The spine. 11. Smooth facet for the trapezius muscle. 12. Acromion process. 13. Nutritious foramen. 14. Coracoid process.

the posterior edge of the bone, by a small triangular face; rapidly increases in its elevation and running obliquely towards the anterior

angle, ceases somewhat short of it; it is then elongated forwards and upwards, so as to overhang the shoulder joint, and to form the acromion process. The cavity above the spine is owing principally to the elevation of the latter, and is called the fossa supra-spinata; it is occupied by the supra-spinatus muscle. The cavity below the spine is the fossa infra-spinata, and is for the infra-spinatus muscle: it is bounded below by a rising of the external margin of the bone. The middle of this fossa presents a swell or convexity, which is a portion of the general convexity presented by the posterior face of the bone. On a vertical measurement of the scapula from the superior to the inferior angle, the spine will be found to traverse it nearly along the base of its upper fourth.

The spine of the scapula is always prominent in the outline of the shoulder, and has a well secured base along the whole of its attachment to the bone, to where it terminates in the acromion process. It leans upwards, and from the increased breadth of its summit, is concave both above and below. The summit itself is somewhat rough, and has inserted into its superior margin the trapezius muscle, while the inferior margin gives origin to the deltoid. The little triangular face at the commencement of the spine is made by the tendon of the trapezius muscle gliding over it. The acromion process arises from the spine by a narrow neck, is triangular, nearly horizontal, and overhangs the glenoid cavity, being elevated about one inch above it. It is slightly convex above and concave below; the external and the internal margins are the longest. The posterior margin is continuous with the inferior edge of the spine of the scapula, and the internal is on a level with the clavicle. At the anterior extremity of the internal margin, is a small, oval, articular face, by which the acromion unites with the clavicle. The margins of the acromion, with the exception of the internal, are rough, and give origin to the deltoid muscle.

The anterior or costal face of the scapula is concave, and obtains the name of the subscapular fossa or the *venter*. It is occupied by the subscapular muscle, the divisions of which, by leaving deep interstices between them, produce corresponding ridges upon the bone that run obliquely upwards and outwards. Along the whole posterior margin of this face of the scapula, is inserted the serratus major anticus.

The posterior or vertebral margin of the scapula is the longest of the three, and is called the base. It is not perfectly straight, but somewhat rounded, especially above the spinous process; and has there, varied degrees of obliquity in different persons. This margin, below the spine, receives the rhomboideus major muscle, and above the spine, the levator scapulæ; at the part between the other two, the rhomboideus minor is inserted.

The external or axillary margin of the scapula, also called the inferior costa, is much the thickest of the three. A superficial fossa placed somewhat posteriorly, forming the inferior boundary of the fossa infra-spinata, begins about two inches from its inferior extremity, and running up to the neck of the bone, lodges the teres minor muscle; a fossa

deeper than this, but in front of it, lodges the anterior fasciculus of the subscapularis muscle. On the exterior face of the inferior angle is a flat surface, from which the teres major muscle and a slip of the latissimus dorsi arise, and at the fore part of this surface the inferior costa is elongated into a kind of process. Just below the glenoid cavity is a small ridge, for the origin of the long head of the triceps muscle.

The superior margin or costa of the scapula is the shortest and thinnest of the three, and is terminated in front by the coracoid notch between it and the coracoid process. The notch is converted into a hole by a ligament, in the living state, and through it pass the suprascapular nerve and blood-vessels.

The glenoid cavity for articulating with the os humeri supplies the place of the anterior angle of the scapula. It is very superficial, and ovoidal, with the small end upwards. Just at the upper end is a small flat surface, from which the long head of the biceps arises. The glenoid cavity is fixed on the neck or cervix, as it is called, at which a general increase in the thickness of the bone occurs, in order to give a strong foundation to this cavity.

From the superior part of the cervix arises the coracoid process, the base of it being bounded in front by the glenoid cavity, and behind by the coracoid notch. The base rises upwards and inwards for half an inch, and what remains of the process, then, runs horizontally inwards and forwards, to become smaller, and terminate in a point. This point is advanced beyond the glenoid cavity, about an inch from its internal margin, and is on the same horizontal plane with the upper end of the glenoid cavity. The upper surface of the coracoid process is rough and undulated; below it is concave, forming an arch under which passes the subscapularis muscle. On the clavicular side of its base is a tuberosity, from which arises the conoidal ligament. The extremity is marked by three surfaces: the interior is for the insertion of the pectoralis minor, the middle for the origin of the coraco-brachialis, and the external for that of the short head of the biceps. The acromial margin of the coracoid process gives origin to the triangular ligament of the scapula, which is inserted into the acromion just below the face for the clavicle.

The scapula is composed of cellular and compact substance. The two laminæ of the latter are in contact in the fossa supra-spinata, and infra-spinata; from which cause the bone is diaphanous at these points.

Of the Clavicle (*Clavicula, Clavicule*).

The Clavicle is a long bone, situated transversely at the upper front part of the thorax, and extends from the superior extremity of the sternum to the acromion of the scapula. It is cylindrical in its middle third, flattened at its external, and prismatic or triangular at its sternal extremity. Besides being shorter, it is more crooked and robust in man than in woman, and different individuals present it under considerable varieties of curvature. The sternal two-thirds of it are convex in front, and concave behind, while the humeral third is concave in

front, and convex behind: this double curvature induces anatomists to compare it with the letter *S*, though it is by no means so crooked.

We have to consider its superior and inferior face, its anterior and posterior edge, and the two extremities. The superior face is smooth, and does not present any marks of importance excepting a depression near the sternum, for the origin of the sterno-cleido-mastoid muscle. The inferior face, near the sternal end, has a rough surface, to which is attached the costo-clavicular or rhomboid ligament: about fifteen lines from the humeral extremity is a rough tubercle for the attachment of the coraco-clavicular or conoid ligament. Between the two ends, a superficial fossa is extended for lodging the subclavius muscle. The sternal two-thirds of the anterior margin are marked by the origin of the pectoralis major; it is there thick; the other part of this margin is

Fig. 56.

An anterior view of the Clavicle of the right side.—1. The anterior face of the body of the bone. 2. Origin of the clavicular portion of the sterno-cleido-mastoid muscle. 3. The sternal extremity of the bone. 4. The acromial extremity of the bone. 5. Articular face for the acromion process of the scapula. 6. Point of attachment of the conoid ligament. 7. Point of attachment of the rhomboid ligament.

thinner and gives origin to the deltoid muscle. The posterior margin presents, near its middle, one or more foramina for the nutritious vessels. The triangular internal end of the clavicle is unequal where it joins the sternum, and is elongated considerably at its posterior inferior corner. The external flat end presents at its extremity a small oval face, corresponding with that on the acromion scapulæ.

This bone is very strong from the abundance of its condensed lamellated structure; but, like other round bones, the cellular matter predominates at its extremities.

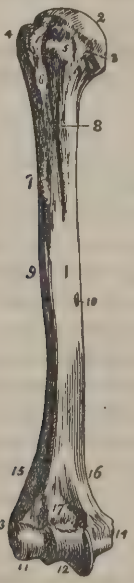
SECT. II.—OF THE ARM (*Os Humeri, L'Humerus*).

The arm extends from the shoulder to the elbow, and has but one bone in it, the os humeri. The latter, in its general appearance, is cylindrical, with an enlargement of both extremities; the superior end presents a general swell, while the inferior is flattened out.

The superior extremity of the os humeri, which is also called its head, is very regularly hemispherical, and has its axis directed obliquely upwards and backwards, to apply itself with more facility to the glenoid cavity of the scapula. The base on which the head reposes is termed neck; it is not more than four or five lines long, and is marked off by a superficial furrow, surrounding the bone. This furrow is more conspicuous above, where it separates the head from two knobs, called the tuberosities.

One of these tuberosities, the external, being placed beneath the acromion scapulæ, is much larger than the other, and bears on its upper face the marks of the tendinous insertion of three muscles. The most internal mark is for the supra-spinatus scapulæ; the middle for the infra-spinatus, and the external, or posterior, for the teres minor. The smaller tuberosity is internal, and placed on a line with the coracoid process; it has but one mark, and that is on its upper face, for the tendinous insertion of the subscapularis muscle. The two tuberosities are separated by a deep fossa, named bicipital, from its lodging the tendon of the long head of the biceps muscle. This fossa is continued, faintly, for some inches down the os humeri; its lower part being bounded, externally, by a rough ridge, indicating the insertion of the pectoralis major, and internally by another ridge, not quite so strong or rough, indicating the insertion of the teres major and latissimus dorsi.

Fig. 57.



An anterior view of the Humerus of the right side.—1. The shaft, or diaphysis of the bone. 2. The head. 3. Anatomical neck. 4. Greater tuberosity. 5. Lesser tuberosity. 6. The bicipital groove. 7. External bicipital ridge, for the insertion of the pectoralis major. 8. Internal bicipital ridge. 9. Point of insertion of the deltoid muscle. 10. Nutritious foramen. 11. Rotula or articular face for the head of the radius. 12. Trochlea or articular face for the ulna. 13. External condyle. 14. Internal condyle. 15, 16. The condyloid ridges. 17. Lesser sigmoid cavity.

The body of the os humeri is the part extended between its extremities. The superior half presents a more cylindrical appearance than the inferior, which is rather triangular. On the middle of the bone, externally, two inches below the insertion of the pectoralis major, exists a triangular elevation into which the deltoid muscle is inserted. At the internal margin of the bone, and on a transverse level with this insertion, is the insertion of the coraco-brachialis muscle; and between the two is the orifice of the canal for the nutritious artery. The front of the os humeri, in its lower half, is flattened on each side down to its

inferior end; on these surfaces is placed the brachialis internus muscle. On a line with the posterior end of the greater tuberosity, and a little below it, an elevation is formed for the origin of the second head of the triceps extensor cubiti. The posterior face of the bone is flattened from this point down to its lower extremity, and accommodates the last named muscle.

The articular surface for the elbow joint is very irregularly cylindrical. The part that joins the radius presents itself as a small hemispherical head (*rotula*), placed on the front of the bone, and with its axis looking forwards. Just above it, in front, is a small depression for the head of the radius in its flexions. The surface which articulates with the ulna (*trochlea*) is more cylindrical, but still irregularly so; for its middle is depressed, while the sides are elevated: the internal side is much broader and more elevated than the external. The lesser sigmoid cavity is just above the front of the ulnar articular surface, and receives the coronoid process. The greater sigmoid cavity is at a corresponding place behind, and receives the olecranon process: the bone where it separates these cavities is very thin: sometimes it is even deficient.

The external condyle is just above the radial articular surface; it is continuous with a ridge three or four inches long, forming the external margin of the bone, and from it, and the ridge together, arise the extensor muscles of the fore arm and hand. The ridge, itself, is bounded, above, by a small spiral fossa, descending downwards and forwards, made by the spiral artery and the muscular spiral nerve. The internal condyle is placed just above the internal margin of the ulnar articular surface: it is much more prominent and distinct than the external, and may be readily felt beneath the skin. A ridge also leads from it and extends upwards as high as the insertion of the coraco-brachialis, but it is by no means so elevated as the external ridge, though it is much longer. From the internal condyle, and the adjoining part of the ridge, arise the flexor muscles of the hand and fore arm.

The os humeri is composed of compact and cellular substance; the latter predominates at the extremities, and the former in the body.

SECT. III.—OF THE FORE ARM.

The fore arm is placed between the arm and the hand, and consists in two straight bones, the ulna and the radius, of which the former is on the side of the little finger, and the latter on that of the thumb.

Of the Ulna (Cubitus).

The ulna, though nearly straight, is not wholly so. It is much larger at the upper than at the lower extremity, and in its general features is prismatic. It has to be considered in its humeral and carpal extremities, and in its body.

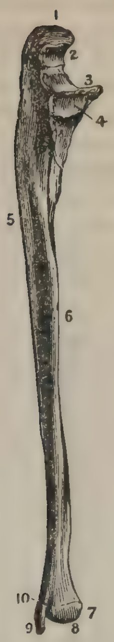
The humeral, or upper extremity, presents the olecranon process at its termination; the coronoid a little below and in front; the greater sigmoid cavity between the two; and the lesser sigmoid on the radial surface of the coronoid.

The olecranon process is rough on its upper face posteriorly, for the insertion of the triceps muscle, and terminates in front in a sharp edge and point, which are received into the greater sigmoid cavity of the os humeri. The coronoid process is a triangular sharp ridge, much elevated, and having a large base; on the lower front of the latter is a roughness for the insertion of the brachialis internus muscle. The greater sigmoid cavity forms all the articular surface between the margins of the two processes. It is divided, transversely, at its bottom, by a superficial roughness, which distinguishes the olecranon from the coronoid portion of it. Besides which, a rising exists in its entire vertical length, which is received into the corresponding depression of the os humeri. The lesser sigmoid cavity has its surface continuous with that of the greater, and presents itself as a small semi-cylindrical concavity, for articulating with the side of the head of the radius. A small fossa, for fatty matter exists just above it, and below it, is a triangular excavation affording space for revolving, to the tubercle of the radius.

The carpal, or lower extremity of the ulna, presents, on the side of the little finger, a process of variable length; the styloid, from which arises the internal lateral ligament of the wrist. At the radial side of this process is an articular face or small semi-cylindrical head, one surface of which looks towards the wrist, and the other is in contact with the radius. On the back of the ulna, between the styloid process and this head, is a groove for the passage of the extensor carpi ulnaris tendon.

The body of the ulna is prismatic, in consequence of three ridges, which extend from the brachial to the carpal extremity, and it decreases very sensibly from above downwards. The first or most prominent of these ridges is on its radial side, and, beginning at the posterior end of the lesser sigmoid cavity, continues very distinct almost to the lower end; it then, however, gradually subsides. From it arises the interosseous ligament. The supinator radii brevis muscle also arises from its beginning, for the distance of a couple of inches. Within this ridge, on the anterior or palmar face of the bone, is a second, more rounded, which, beginning at the internal margin of the coronoid process, extends down to the styloid process. For the greater part of its length, it gives origin to the flexor profundus digitorum, but just above the carpus, the pronator quadratus arises from it. The third ridge begins at the external margin of the olecranon, and runs in a serpentine way to the inferior end of the ulna, but becomes almost indistinct at its lower part. To the upper fourth of this ridge, is attached the anconeus muscle, which reposes in a hollow between it and the beginning of the first-mentioned ridge. On the posterior surface of the bone, just below

Fig. 58.



An external view of the Ulna of the right side. 1. Olecranon process. 2, 3. Greater sigmoid cavity. 3. Coronoid process. 4. Lesser sigmoid cavity. 5. External surface; just above the number reposes the anconeus muscle. 6. Ridge for the interosseous ligament. 7. The small head for the radius. 8. The carpal surface. 9. The styloid process. 10. Groove for the extensor carpi ulnaris tendon.

the olecranon, is a triangular face an inch and a-half or two inches long on which we lean, and which is placed just under the skin; it may, therefore, be readily felt in the living body.

The three ridges of the ulna divide it into as many surfaces which are each modified by the muscles lying upon them. The anterior surface presents, just two inches above the middle of the bone, the canal for the nutritious artery, running obliquely upwards.

The body of the ulna is compact, the extremities, and more abundantly the upper, are cellular.

Of the Radius (Radius).

The radius is shorter than the ulna, is placed on its external side, and extends from the os humeri to the wrist. It is smaller at the humeral than at the carpal extremity, and though nearly straight is somewhat arched outwardly, which is rendered very distinct by applying the ulnar margin of it to a plane surface, and thus letting it rest upon the two ends of the arch. This conformation strengthens it, and modifies its range of motion around the ulna. It is to be considered in its extremities and body.

The superior or humeral extremity presents a cylindrical head,

which bears all around it the marks of a cartilaginous incrustation, broader on the ulnar than on the other side. The broader part plays in the lesser sigmoid cavity of the ulna, while the other is in contact with the annular ligament. A superficial hollow also exists on the upper surface of this head, which receives the convexity (*rotula*) of the articular face of the external condyle of the os humeri. The head of the radius is placed upon a narrow part called the neck, of from six to ten lines in length. Immediately below the neck, on the ulnar side, is a rough protuberance or tubercle, the bicipital, along the posterior half of which is the insertion of the biceps flexor cubiti.

Fig. 59.

An anterior view of the Radius of the right side. 1. Cylindrical head. 2. Surface for the lesser sigmoid cavity of the ulna. 3. The neck of the radius. 4. Its tubercle, for the insertion of the biceps muscle. 5. Interosseous ridge. 6. Concavity for the lower end of the ulna. 7. Carpal surface. 8. Styloid process. 9. This number is just above the surface for the pronator quadratus muscle.

The lower or carpal extremity of the bone is augmented considerably in volume, and is flattened out transversely. The carpal surface presents a long superficial cavity; it is bounded externally by the styloid process, from which proceeds the external lateral ligament, and ends on its ulnar side, by a small cylindrical concavity, for receiving the lower end of the ulna. The former or superficial cavity is divided into two, by a slight ridge in its short diameter; the division next the styloid process receives the scaphoid bone, and the other the os lunare. At this extremity also a ridge exists on the front of the bone for forming the margin of the articular face, and giving origin to the capsular ligament; the origin of the ligament being further marked, near the styloid process, by a deep triangular depression, in many subjects. The posterior and external faces of the bone, here, are rendered irregular by several grooves and ridges. The large groove next to the cylindrical concavity for the ulna transmits the tendons of the extensor com-

munis digitorum and indicator muscles; also the tendon of the extensor major pollicis, which forms a channel somewhat distinct, and on the styloid side of the groove. Next to this is another large groove for the tendon of the extensor carpi radialis brevior, and of the longior; and on the styloid side of the radius is the third groove for transmitting the tendon of the extensor minor pollicis, and of the extensor ossis metacarpi pollicis. The anterior margin of this groove is formed by a small crista or ridge, into which is inserted the tendon of the supinator radii longus.

The body of the radius is somewhat three-sided, and therefore presents three ridges. One, on its ulnar side, extends from the bicipital protuberance to the lower end, and gives origin to the interosseous ligament; it is sharp and well marked. Another, on the outer or styloid margin of the bone, also begins at the bicipital protuberance, and terminates in the styloid process. The upper part of this ridge is curved, has the supinator radii brevis inserted into it, and a portion of the flexor digitorum sublimis arising from it; at its lower part the pronator quadratus is inserted. The third ridge is on the posterior face of the radius, and arising insensibly from below its neck, is principally conspicuous in the middle third of the bone: it runs down, however, to the carpal extremity, and, becoming more prominent there, separates the two larger grooves from each other. This ridge is shorter, and not so elevated as the other two.

These three ridges form as many surfaces to the radius, of which the anterior, augmenting gradually in its descent, affords attachment to the flexor longus pollicis above, and to the pronator quadratus below; near its middle, or somewhat higher, is a canal, slanting upwards, for the nutritious artery. The posterior surface has the extensor muscles of the thumb and the indicator lying upon it. The external surface presents a roughness, just above its middle, for the insertion of the pronator teres; and below it is covered by the radial extensors, which are crossed by the extensor metacarpi and the extensor minor, pollicis.

The body of the radius is compact; its extremities are cellular.

SECT. IV.—OF THE HAND.

The hand consists of the carpus, metacarpus, and phalanges, and has in its composition twenty-seven bones, to which number may be added the two sesamoids.

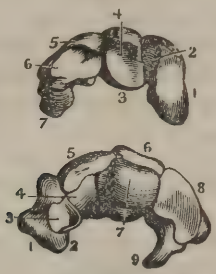
Of the Carpus (*Carpé*).

The carpus, or wrist, is next to the bones of the fore arm. Eight bones compose it, which are arranged into two rows, one adjoining the fore arm and the other the metacarpus:—they are called first and second rows. These bones present very diversified forms and a number of articular faces, which render them difficult to be distinguished from each other.

The first or anti-brachial row has in it the os scaphoides, lunare,

cuneiforme, and pisiforme. The second, or metacarpal row, has in it the os trapezium, trapezoides, magnum, and unciforme.

Fig. 60.



The two rows of bones of the Carpus, right side. *The upper, or first row, viewed on its inferior articulating surface.* 1. The scaphoides. 2 Its concave articular face. 3. The lunare. 4. Its concave articular face. 5. The cuneiforme. 6. Its articular face. 7. The pisiforme. *The lower, or second row, viewed on its superior articulating surface.* 1. The trapezium. 2. Its process. 3 An articular face. 4. The articular face of the trapezoides. 5. The posterior surface of the trapezoides. 6. The magnum. 7. Its head, or upper articulating surface 8. The unciforme. 9 Its hook-like process.

Of the Scaphoides (Scaphoide).

This bone is on the styloid half of the end of the radius, and is distinguishable in a set by its greater length. It is convex above and concave below. The convexity forms only a half of its upper surface, and joins the radius; the other half is rough, and makes a knob at its extremity. The concavity on the lower surface is large enough to receive the end of a finger, and joins the magnum. Between the concavity and the convexity, but on the dorsal surface of the bone, at its outer end, is a second convexity, of an oblong shape, for articulating with the trapezium and trapezoides. Between the two convexities is a small fossa for the capsular ligament. The palmar or anterior face shows a curve in the bone. The knobbed extremity projects beyond the styloid process of the radius. The other extremity, which is narrow, joins the os lunare.

Of the Lunare (Semilunaire).

This bone is at the ulnar side of the preceding, and may be distinguished by the semi-lunated shape of the surface joining the scaphoides. Its upper surface is convex where it articulates with the radius; the lower face is concavely cylindrical, to receive the magnum and unciforme. The ulnar side is a plain surface which joins the os cuneiforme. Its dorsal side is rather thinner than its palmar.

Of the Cuneiforme or Pyramidale (Pyramidal).

This bone is united to the ulnar side of the lunare, and may be distinguished by its representing somewhat a triangular pyramid. The surface next the lunare is plain, but the other extremity, being the boundary of the wrist in that direction, is rough. Above it presents a small convexity, adjoining the surface for the lunare, whereby it enters

partially into the upper wrist joint. Its inferior sûrface is concavo-convex, the convexity being towards the ulnar end. On its palmar side it presents a circular plain surface for the os pisiforme.

Of the Pisiforme (*Pisiforme*).

This bone is placed on the front or palmar surface of the last, and may be distinguished by its being smaller than any other in the carpus, by its spheroidal shape, and by its presenting but one articular face, and that corresponds with one on the cuneiforme. It is always so prominent as to be felt, without difficulty, at the ulnar extremity of the wrist, and is very movable. Its inferior end is somewhat elongated towards the unciform process of the unciforme and united to it by ligament. This bone is in a slight degree concave on the side looking to the radius.

Of the Trapezium (*Trapeze*).

This bone is placed at the radial end of the second row; its shape is exceedingly irregular, but it may be generally distinguished by being a bone of the third magnitude as regards the second row. It is better for the student to find out first the surface by which it articulates with the metacarpal bone of the thumb, which he can do in a short time by a comparison of the surfaces of the two bones. This being successful, will establish a clue to the other surfaces, and to the relative position of the bone. The thumb surface is a concave cylindrical trochlea, placed on the radial side of the trapezium, and looking downwards and outwards. On the reversed or upper side is a small concavity, which receives the dorsal convexity of the scaphoid bone. Continuous with this concavity is another on the ulnar side, which receives a corresponding convexity of the trapezoides. Between this concavity and the one for the thumb is a small surface, by which the trapezium articulates partially with the metacarpal bone of the fore finger. The dorsal face is rough and unequal. The palmar face is unequally divided by a high ridge or process, at the ulnar side of whose root is a deep fossa for the tendon of the flexor carpi radialis.

Of the Trapezoides (*Trapezoide*).

It is placed at the ulnar side of the last bone, and is the smallest in the second row. There is no liability of confounding it with any other bone of the carpus, as it is the least of any, excepting the pisiforme. The greater difficulty is the adjustment of it in the separated bones: the following rule, however, will serve. It is surrounded by articular faces on its sides, but the dorsal surface presents a broad base, while the palmar extremity is redûced in size. Holding the bone with a reference to these, it will be observed that one side is very crooked and concave, while the reversed or opposite one is convex. The latter fits against the surface of the trapezium which has been indicated, while the former embraces the side of the os magnum just below its head. The metacarpal surface of the trapezoides is long and elevated in its

middle, for being received into the root of the metacarpal bone of the fore finger, while the upper surface presents a long concavity for receiving a part of the dorsal convexity of the scaphoides.

Of the Magnum (Grand Os).

It is placed at the ulnar side of the trapezoides, and from its being larger than any other bone in the carpus, will scarcely be mistaken. Its ulnar side is flat, and presents a plain surface for articulating with the unciforme. The radial side is uneven and rather indistinctly marked where it joins the trapezoides, but the latter surface will be found near the middle of this side just below the head. The upper surface of the magnum is formed into a hemispherical head, the radial side of which reposes in the concavity of the scaphoides, while the ulnar side is in the concavity of the lunare. Its metacarpal surface is triangular, convex, and winding, by which it joins the metacarpal bone of the middle finger. On the radial side of this surface is a small one continuous with it, whereby the magnum articulates partially with the metacarpal bone of the fore finger. The posterior or dorsal face is broad, while the palmar is more narrow.

Of the Unciforme (Os Crochu).

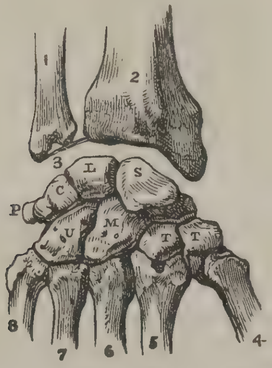
It is placed at the ulnar side of the magnum, is nearly of the same size, but readily distinguishable from it by its long crooked process as well as by its peculiar shape. Its radial side is plain where it joins the magnum; the reversed or ulnar side is brought to a thin edge. The metacarpal surface presents two distinct concavities; the one next to the ulnar edge is for the metacarpal bone of the little finger, and the other for that of the ring finger. The upper surface is convex and winding, having its ulnar margin almost touching the surface for the metacarpal bone of the little finger. The most considerable portion of the upper surface reposes upon the cuneiform, and the remainder upon a part of the concavity of the lunare. The posterior face is broad and rough, while the palmar is narrower. From the ulnar side of the latter, projects the unciform process already alluded to.

The two ranges of carpal bones, thus shaped, present, when articulated or united together, an oblong body, the greatest diameter of which is transverse. Its posterior face is semi-cylindrical and arched, while the anterior face is concave for the passing of the flexor tendons. Two protuberances are found on each extremity of the palmar surface. Those at the ulnar end are the pisiforme, and the unciform process of the unciforme; those at the radial end aré the protuberance at the radial end of the scaphoides, and the sort of unciform process from the trapezium bounding the radial margin of its groove. These several prominences may, with a little attention, be readily distinguished beneath the skin. The superior face of the carpus, which articulates with the lower end of the radius and ulna, presents an oblong convex head formed by the scàphoides, the lunare, and very partially by the

cuneiform. The inferior face of the carpus presents a very diversified surface, subdivided into five distinct ones, each of which is fashioned according to the shape of the metacarpal bone, with which it has to articulate.

The central joint of the wrist, formed between the two rows of bones, is very deserving of attention. The first row is convex on its radial end, the convexity being formed on one half of the scaphoides; to the ulnar side of this there is a deep concavity formed by the other half of the scaphoides, by the lunare and the cuneiforme. The upper surface

Fig. 61.



A posterior view of the articulations of the Bones of the Carpus in the Right Hand.—1. The ulna. 2. The radius. 3. Inter-articular fibro-cartilage. 4. Metacarpal bone of the thumb. 5. Metacarpal bone of the first finger. 6. Metacarpal bone of the second finger. 7. Metacarpal bone of the third finger. 8. Metacarpal bone of the fourth finger. S. The scaphoides. L. The lunare. C. The cuneiforme. P. The pisiforme. T, T. Trapezium and trapezoides. M. The magnum. U. The unciforme.

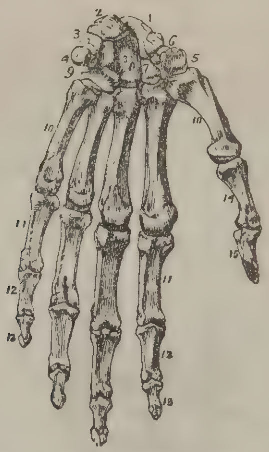
of the second row fits very accurately upon the lower surface of the first. Its radial end is, therefore, a concavity formed by the trapezium and trapezoides, which receives the convexity of the scaphoid; then a very large prominent head is formed by the magnum and unciforme, and received into the concavity of the first row. The magnum reposes upon the scaphoides and part of the lunare; the unciforme upon the remainder of the lunare, and the whole of the cuneiforme. The carpal bones consist of cellular matter enclosed by condensed lamellated substance.

Of the Metacarpus.

The metacarpus is situated between the carpus and the phalanges of the fingers and thumb. It consists of five bones, one for the thumb and one for each finger. The four latter are parallel, or nearly so with each other; but the first diverges considerably, and is so placed as to traverse the others in front during its motions. These bones are rounded in their middle, are enlarged at their extremities, and are bent so as to be concave on the anterior face, and project behind. Their sides are impressed by the intervening muscles. That of the thumb is the

shortest, the others decrease successively in length from the fore to the little finger.

Fig. 62.



An anterior view of the Left Hand.—1. The scaphoides. 2. The lunare. 3. The cuneiforme. 4. The pisiforme. 5. The trapezium. 6. Groove for the flexor carpi radialis tendon. 7. The trapezoides. 8. The magnum. 9. The unciforme. 10, 10. The five metacarpal bones. 11, 11. First row of phalanges. 12, 12. Second row of phalanges. 13, 13. Third row of phalanges. 14. First phalanx of the thumb. 15. Last phalanx of the thumb.

Of the First Metacarpal Bone, or that of the Thumb.—It is placed upon the trapezium: and besides being the shortest, is also the broadest of any. Its upper end is concave from side to side, and raised in the middle of the articular face, to present a fit surface to the trapezium. Its lower end is semi-cylindrical and protuberant, and elongated in front into a trochlea, on either side of which reposes a sesamoid bone. The posterior face of its body is flat and very slightly bent; the anterior is concave in its length, and is divided into two surfaces by a middle ridge. A roughness exists on either side, at its lower end, for the attachment of the lateral ligament.

Of the Second Metacarpal Bone, or that of the Fore Finger.—The greater length of this bone gives it a distinctive character. It is placed upon the trapezoides, and articulates laterally also with the trapezium and the magnum. Its carpal or upper end presents, in the middle, a deep antero-posterior concavity for receiving the trapezoides, at the radial side of which is a small plain face for articulating with the trapezium, and at the ulnar side an oblong surface, the upper margin of which joins the magnum, and the remainder is in contact with the third metacarpal bone. The lower end presents a convex head, extended in front to permit the flexion of the finger, on each side of which head is a concave rough surface for the lateral ligament, it being bounded by a flat cone behind. The posterior face of the bone presents a triangular flat surface, the base of which is towards the finger or phalangial end. The palmar face is concave, longitudinally, and divided by a middle ridge into two surfaces, each of which is compressed by the interosseous muscles. A tubercle exists on the back of the bone just below

its carpal end, for the insertion of the tendon of the extensor carpi radialis longior, and another in front for that of the flexor carpi radialis.

Of the Third Metacarpal Bone.—This is a little shorter than the second, and is nearly of the same size, but its carpal extremity is very different. The latter is triangular, and is bounded on its radial side by a sort of styloid process, with a tubercle on the posterior face of it, into which the tendon of the extensor radialis brevior is inserted. It is placed upon the magnum, to which it joins by a slightly concave, winding surface. It also presents, continuous with the same surface, an oblong face which joins the second metacarpal bone, and, on the reversed side, a single long or two round facets, which are contiguous to the fourth metacarpal bone. In regard to its lower or phalangial extremity and body, this bone resembles closely the one last described.

Of the Fourth Metacarpal Bone.—This bone is placed upon the unciforme, but has a very small surface articulating with the magnum. It is much smaller and shorter than the third metacarpal, and readily distinguishable by these circumstances. The carpal surface, by which it joins the unciforme, is triangular and slightly convex; its radial edge touches the magnum. Continuous with this edge are two small faces, slightly convex, which join the contiguous faces of the third metacarpal bone. On the reversed side of the fourth metacarpal is an oblong concave face which joins the carpal end of the fifth metacarpal bone. In regard to its body and phalangial extremity, this bone resembles the two preceding, and therefore does not require a particular description.

Of the Fifth Metacarpal Bone.—It is placed upon the unciforme exterior to the last, and is both smaller and shorter than the fourth. The carpal extremity presents a semi-cylindrical face, for articulating with the unciforme, at the radial margin of which is an oblong facet, for joining the fourth metacarpal: just below the outer margin is a small tuberosity, into which is inserted the tendon of the extensor carpi ulnaris. The lower or phalangial extremity, like that of the others, presents a rounded convex articular face, extended in front for the flexion of the first phalanx. The body also corresponds with that of the others, excepting that it is more flat in front.

Of the Phalanges.

The fingers (*digiti*) are named numerically, beginning at the fore finger; they are also named from their functions, as Indicator, Impudicus, Annularis, and Auricularis.

Each finger has three bones in it, called its phalanges: the bone adjoining the metacarpus is the first phalanx, the middle bone is the second, and the other the third. (See Fig. 62.)

The *first* phalanx is the largest, and curved forwards on the side of prehension, so as to be concave in front and projecting behind. Its

posterior face is semi-cylindrical; the anterior face is flattened in its length. The two surfaces run into each other by forming a ridge on either side, from which arises the theca of the flexor tendons. The metacarpal extremity is enlarged, and presents a superficial cavity, which receives the end of the metacarpal bone. On either side of this end of the bone is a small tuber for the lateral ligament. The lower extremity is also enlarged and flattened at its sides. Its articular face is extended in front, and presents two condyles, or small heads, for joining the second phalanx.

The *second* phalanx is second in size and length. It is bent also, being semi-cylindrical on its posterior face, flattened on its anterior, which is somewhat concave in its length, and the two faces form a ridge, on either side, into which the tendon of the flexor sublimis is inserted, and from which arises the theca of the flexor tendons. Its extremities are slightly enlarged: the articular face of the upper presents two superficial cavities for the condyles of the first phalanx: the articular face of the lower extremity presents a trochlea, with a slight elevation at each side.

The *third* phalanx is the smallest of the three, is straight, and is very different from the others. Its superior extremity being enlarged, presents an articular face, having two superficial cavities, which adjust themselves to the corresponding face of the second phalanx. The inferior extremity is expanded, semicircular, thin, and flattened, its margin and front being very rough. The posterior face of the body is convex. The anterior is flat, and receives upon the front of its base the insertion of the flexor profundus tendon.

The phalanges of the middle finger (*Impudicus*) are larger and longer than the others. The phalanges of the fore finger (*Indicator*) are next in size, but not in length, as the ring finger is rather longer than it. The phalanges of the ring finger (*Annularis*) are next in size, and those of the little finger (*Auricularis*) the smallest and shortest of any.

The Thumb (*Pollex*) having but two phalanges, the first corresponds sufficiently in its general form with the first one of the fingers: it may be distinguished, however, by its shortness and additional size. The second phalanx of the thumb, corresponding with the third of the fingers, is only to be distinguished by its additional bulk and length.

All the metacarpal and phalangial bones have a condensed lamellated structure externally, and a cancellated one internally; and, like other bones, are more compact in their bodies than at their extremities.

There are two small hemispherical bones, called Sesamoid (*Ossa Sessamoidea*), placed upon the trochlea at the lower extremity of the metacarpal bone of the thumb. They answer the purposes of patellæ, and facilitate the action of the short flexor muscle. The metacarpal bones of some of the fingers are, in robust individuals, occasionally furnished in the same way.

SECT. V.—OF THE DEVELOPMENT OF THE UPPER EXTREMITIES.

At birth, the upper extremities are larger in proportion to the lower than they are at any subsequent period of life, owing, perhaps, to the umbilical arteries, which carry off to the placenta of the mother the greater part of the blood which afterwards goes to the lower extremities. The nearer a fœtus may be to the embryo state, the more marked is this relative size of the extremities, which becomes gradually less obvious till the age of puberty, when it almost entirely disappears.

At birth, the ends of the clavicles are, in consequence of their advanced ossification, much less cartilaginous than those of the other cylindrical bones. Its shape, also, approaches nearly to that of the adult state.

The scapula is also in an advanced stage of ossification and large. The glenoid cavity, though still cartilaginous, is well sustained by a bony basement coming from the central point of ossification of the scapula, and is much further ossified than the acetabulum. The acromion, the coracoid process, and the angles are still cartilaginous.

The os humeri is cartilaginous at both extremities, which are also larger, proportionally, in consequence of this state. Its inferior extremity is remarkable for the size of that portion of it which articulates with the radius.

In the fore arm, the extremities of its bones are cartilaginous. The ulna has the olecranon large, while its coronoid process is comparatively small; the greater sigmoid cavity is, consequently, not so concave as in the adult. The position of the radius, at its upper end, is somewhat peculiar, for it is much more anterior than in the adult; a circumstance depending upon the greater size of the rotula of the humerus, upon which it rests. This arrangement renders pronation more extended in the fœtus, as the radius always crosses the ulna with additional facility, by being placed more anterior to it. This fact is strongly exemplified in the bones of the fore extremity of animals. Bichat observes that this greater extent of pronation exposes the annular ligament to being stretched considerably behind, and, consequently, the radius to luxations at its head; an accident by no means unfrequent among children. The late Dr. Physick says that he has often seen it in consequence of nurses incautiously seizing them by the fore arm to help them over gutters, or to render them other assistance. It happens while the arm is in a state of pronation; for the weight of the body, by hanging from it, increases the position, distends the ligaments, and produces luxation. As the bones of the fore arm in the fœtus are nearly straight, the interosseous space decreases gradually from above downwards.

The carpus is entirely cartilaginous at birth, and consists in the same number of pieces that it does in the adult. Its articular cavities are well formed. Its size is proportionate to what it is in the adult. In this respect it differs from the cartilaginous extremities of the round bones, which are always larger from being in this state. The carpus, therefore, appears small in the fœtus.

The metacarpus is cartilaginous at its extremities, but ossified in the middle. The phalanges are in the same state.

SECT. VI.—OF THE MECHANISM OF THE UPPER EXTREMITIES.

The scapula and clavicle are for the superior extremity what the os innominatum is for the inferior; in consequence of which, some anatomists consider them as a part of the trunk of the body. Though the convenience of anatomical description generally requires them to be associated with the upper extremity, I shall depart from the rule on the present occasion, and view them only as the basis of the attachments and motions of the os humeri, and of the remaining parts of the superior extremity.

The upper extremities, considering them as commencing with the os humeri, differ materially in their position from the lower. They are placed much farther behind; of which one may be satisfied fully by drawing a line from the middle of the glenoid cavity to the middle of the acetabulum of the same side; the body being perfectly erect at the time, the line will be found oblique. The advantage of this arrangement is to give greater latitude of motion to the upper extremity than if it had been placed more in front. Another important benefit is, that by the bulk of the shoulder being placed behind the centre of gravity, the erect position is more easily preserved; a different position of it, by throwing its weight forwards, would have had a continual tendency to produce falls, and to effect somewhat, in man, the same inconvenience which is felt by the quadruped in the erect position. Another point, also of some interest in the position of the upper extremities, is the distance to which they are separated from each other by the lateral projection of the scapulæ, and, consequently, of the glenoid cavities, a distance owing to the length of the clavicles, and which considerably exceeds the distance between the heads of the ossa femorum.

When the whole length of the superior is compared with that of the inferior extremities, the difference is not so great as one may suppose. The former is ascertained by a line drawn from the head of the os humeri to the end of the middle finger: as the hand is parallel with the bones of the fore arm, its length is also included, which amounts to a considerable portion of the whole. On the contrary, from the foot being articulated at right angles with the leg, only its thickness contributes to the length of the lower extremity. As far, however, as individual bones are concerned, those of the upper extremity, with the exception of its phalanges, are uniformly shorter than the corresponding bones of the lower extremity. The os humeri is much shorter than the os femoris—the bones of the fore arm than the bones of the leg—the carpal and metacarpal bones than the tarsal and metatarsal.

The bones of the upper extremity are much less robust than those of the lower, a very certain indication of the difference of the uses for which they were intended. Their articular surfaces are arranged for great variety and extent of motion, in the seizing and handling of bodies; whereas in the lower extremity, they are fashioned so as to suit the comparatively limited number of motions requisite for progression,

and to sustain the body firmly in the upright position. The carpus and metacarpus are much smaller than the tarsus and the metatarsus, because the latter are intended to support a great weight. On the contrary the phalanges of the fingers are much better developed than the phalanges of the toes, because the latter are not destined to hold bodies and to examine them, and may be dispensed with, both in standing and in progression.

The motions of the upper extremity are immensely varied, and by a short attention to them, some useful hints may be obtained in regard to dislocations.

SECT. VII.—OF THE MOTIONS OF THE SHOULDER.

The clavicle performs a very important office in the actions of the shoulder, by preserving it in a fit attitude for the motions of the upper extremity. The simple movements of the clavicle, of which the sterno-clavicular articulation is the centre, are those of elevation, depression, advancing, and retreating, and a rapid succession of these produces circumduction. The weight of the shoulder is also sustained by the clavicle, by the latter being fastened at the extremity next to the sternum, and having in the cartilage of the first rib a fulcrum, intermediate to this attachment and to the weight at its other end. This is proved conclusively by its fracture; for in that case the shoulder invariably falls down, from the lever being broken which kept it up.

The clavicle, also, by keeping the glenoid cavity at a distance from the side of the thorax, and directed outwards, gives great facility and latitude to certain motions in the human subject; and which are performed with difficulty, and very imperfectly, in animals not having a clavicle. A principal one of these motions is circumduction, manifested by the elbow being turned inwards or outwards, and in most persons extends to three-fourths or even an entire circle. This motion concurs in the action which brings the hand to the mouth, in consequence of which such an action is performed with difficulty when the clavicle is broken. After an accident of the kind, the head, instead of remaining stationary as usual, is advanced towards the hand, without which the act cannot be accomplished. A certain length in the clavicle seems indispensable to the vigorous and perfect action of the shoulder in particular movements; if the clavicle be disproportionately long, as in females, these movements are executed with inevitable awkwardness and imbecility; as, for example, in their throwing a stone.

The scapula presents a movable basis, on which the motions of the arm are accomplished. Its primary motions are such as have been assigned to the clavicle, in consequence of the connection between these bones; besides which, in all the extreme motions of the humerus, backwards or forwards, the scapula is caused to perform a partial rotation, the axis of which is indicated by a line drawn from the end of the acromion to the inferior angle. When the arm is brought very far forwards, the inferior angle of the scapula is carried outwards, and somewhat elevated, while the superior angle is directed towards the

spine, and somewhat depressed. But when the arm is carried very far backwards, the inferior angle is directed towards the spine, and the superior angle looks forwards and upwards. The clavicle in these cases moves inconsiderably, as the scapula enjoys a pendulous motion, and its point of suspension is the outer end of the clavicle; at which place the oblong articular surfaces slide laterally upon each other and decussate. The extreme degrees of these motions tend to dislocate this articulation, but the accident is prevented by the strong coraco-clavicular ligament, which, by its peculiar position and conformation, resists firmly at a certain point. In the abduction and adduction of the arm, the scapula is motionless.

SECT. VIII.—OF THE MOTIONS OF THE SHOULDER JOINT.

The os humeri is susceptible of elevation, depression, advancing, retreating, circumduction, and rotation.

In elevation, the head of the os humeri slides downwards in the glenoid cavity, and distends the lower part of the capsular ligament. In this motion the scapula is apt to follow it; in which case there will be a less degree of distension in the capsular ligament. If the os humeri be carried forwards, its elevation is performed with much more ease, from the readiness with which the scapula follows it; but if it be carried backwards, this facility is much diminished. It is in the latter position, therefore, that dislocations downwards are most disposed to occur when violence is offered to the joint. If in every case the scapula could follow the motions of the os humeri, so as to present fairly its glenoid cavity, luxations would be comparatively rare; but generally the violence offered transmits its momentum so speedily to the joint, that the muscles of the scapula are taken by surprise, and have not time to adjust properly the glenoid cavity.

In the depression of the os humeri, the parts constituting the shoulder joint are in their most natural and easy position. The capsular ligament becomes very loose below, and is somewhat stretched above. Any degree of force which might be applied to the member is warded off and its direction changed by the intervention of the trunk of the body. Should, however, the force be applied directly in the axis of the bone, the projection of the acromion process, and the strength of the triangular ligament of the scapula, would arrest the dislocation.

When the os humeri is advanced, the posterior part of the capsular ligament is put upon the stretch; but the form and arrangement of the articular surfaces are somewhat favorable to this position, and accordingly it is one of but little inconvenience. When the os humeri is retracted, its head, by being directed forwards, exercises considerable force upon the fore part of the capsular ligament, and when assisted by an external momentum is disposed to dislocation forwards and inwards.

The motion of circumduction is very extensive in the shoulder joint; and by it the os humeri describes a cone, of which the glenoid cavity is the apex. It is a regular succession of the movements already mentioned, and in consequence of all the motions forwards of the os humeri being

more easy and natural, the axis of the cone instead of being directly outwards, is somewhat forwards.

By rotation, is meant the revolving of the os humeri upon itself. The centre of this movement is not the axis of the bone, but is removed to one side of it, by the lateral projection of the head. The neck, however, is too short and thick to permit any great extent to this motion; it, accordingly, is limited in such a way as never to amount to luxation. Its greatest extent, in most persons, does not exceed the describing of half a circle, which may be ascertained by applying a finger upon the internal condyle of the os humeri. By it the capsular ligament is rendered, alternately, loose and tense on its front and back parts. Bichat observes, that in the anchylosis of the elbow joint, this motion, by habit, is much augmented, so as to supply the want of rotation of the head of the radius upon the ulna. The scapula and the clavicle do not vary their position in rotation.

SECT. IX.—OF THE MOTIONS OF THE FORE ARM.

There are two kinds of motion in the fore arm. In the one, the fore arm is flexed, and extended upon the arm; and in the other, the radius only changes its position in regard to the ulna.

1. The ulna is the essential agent of the first, in consequence of its manner of articulation with the os humeri; the radius is only accessory, and is drawn by the ulna into a participation in its motions. These two bones, it will be recollected, are disposed of in an inverse manner, the larger part of the ulna being above, while the larger part of the radius is below. This arrangement causes the ulna to present the principal articular surface for union with the os humeri, while the radius affords the principal surface to the carpus; it also gives to the whole fore arm a great uniformity in its transverse diameter. The fore arm executes, upon the arm, flexion, extension, and lateral inclination.

Where the flexion is complete, the coronoid process is received into its cavity, on the front of the os humeri; and the olecranon, having left its cavity, is placed below the condyles. In this state the capsular ligament is stretched at its posterior part, while the anterior is thrown into folds, and is relaxed along with the lateral ligaments. In the demi-flexion of the arm, there is a more equal degree of tension of the several ligaments. When the os humeri is reposing in its most easy attitude, at the side of the body, if the fore arm be flexed, its line of motion directs the hand towards the mouth; a circumstance which is accounted for by the peculiar obliquity of the trochlea, on the lower part of the os humeri, upon which the ulna revolves, and is independent of any special act of volition. It is said that man, above all other animals, has the mechanism of the upper extremity most particularly addressed to the latter motion, to the perfection of which the clavicle is indispensable. It is in consequence of this application of the clavicle that, if it be broken, man, like animals which are entirely deprived of it, will, in the flexions of the fore arm, more easily carry the hand to the opposite shoulder than to the mouth.

In the full extension of the fore arm, the olecranon process, being received into its cavity, is much above the condyles of the os humeri. The lateral ligaments, as well as that part of the capsule on the front of the joint, are in a state of tension. When the extremity is in this position, a fall upon the hand may produce a dislocation backwards. In this case the fore arm being fixed, the coronoid process affords the surface upon which the principal momentum of the fall is felt. If the ligaments on the front of the joint be not strong enough to withstand the force, they are lacerated, and the articular surfaces, passing each other, the upper parts of the ulna and radius are driven behind the os humeri. Bichat asserts, that nothing is more easy than to produce such a luxation on the dead body by a similar proceeding, and that he has repeatedly done it—that it is about as easy to produce this dislocation, as it is difficult to effect one at the scapulo-humeral articulation. In a moderate extension of the fore arm, produced by a small weight suspended on the hand at arm's length, there is a well-marked pressure of the inferior extremity of the os humeri against the ligaments in front of the articulation, which is augmented by a tendency of the ulna to describe the arc of a circle, from above downwards, and to separate itself from the os humeri. In this case the muscles which flex the fore arm are kept so much in the line in which they contract, or are so little removed from the axis of their own motion, that they contribute but little to sustain the fore arm in situ; the weight is, therefore, actually sustained by the ligaments in front of the articulation. But they being pressed and drawn in the manner mentioned, such great pain and weariness are produced as to render a continued suspension of the weight insupportable; the experimenter is, therefore, in a short time, under the necessity either of casting off the weight or of giving such a degree of flexion to the fore arm as will allow the muscles to contract more advantageously.

Besides flexion and extension, the ulna has a sort of rocking motion when the fore arm is only half bent; but when the latter is at either extreme of the former positions, this motion is imperceptible, owing to the nature of the articular surfaces and the resistance of the ligaments.

2. In the rotations of the radius upon the ulna, the latter is almost motionless, excepting the case specified in the last paragraph. The position of the radius on a plane somewhat anterior to the ulna, its small cylindrical upper extremity, and its broad lower one, all concur in facilitating rotations forwards and backwards. It is owing to the hand following these motions that the first is expressed by the term pronation, in which the palm of the hand is directed downwards; and the second, supination, in which the palm is upwards and the back of the hand downwards.

Pronation is the most common, and, consequently, the easiest position to the fore arm, when not carried to an extreme: it is adopted involuntarily, simply by the action of the ligaments and the particular shape of the articulating surfaces of the bones. It is the posture most generally suited to the examination and grasping of surrounding bodies. In order that it may be accomplished fully, the superior extremity of the radius rolls on its own axis, in the loop formed by the annular

ligament and the lesser sigmoid cavity of the ulna; while the lower extremity revolves around the little head of the ulna below. The middle part of the radius crosses that of the ulna, and the interosseous space is diminished. An excess of this motion will produce luxation either above or below, but more easily at the latter place; both on account of the greater extent of motion there, and of the comparative weakness of the ligaments.

In supination, a movement the reverse of what is described takes place; the radius revolves outwardly, and is brought parallel with the ulna. If by any force it be carried beyond this line, a dislocation may occur, in which the little head of the ulna, abandoning the sigmoid cavity of the radius, will be thrown in front of it. An accident, however, said to be very unusual.

Bichat considers the cartilage between the ulna and the cuneiforme as a principal obstacle to these luxations; but when it is insulated or separated from the cartilage of the radius, as sometimes occurs, the joint is very much weakened thereby, and more exposed to dislocations.

SECT. X.—OF THE MOTIONS OF THE HAND.

The hand, as a whole, performs upon the fore-arm flexion, extension, lateral inclination, and circumduction. As it only follows the motion of the radius in pronation and supination, and does not contribute in the slightest degree to either, its appropriate motions can all be performed independently of them.

In flexion the convex head, formed by the first range of carpal bones, slides from before backwards in the concavity which receives it. The posterior part of the capsular ligament is stretched, and the anterior thrown into folds, while the lateral ligaments remain at their ease. In extension, with the exception of the lateral ligaments, the phenomena are reversed. This extension, as is well known, not only brings the hand into the same line with the bones of the fore arm, but carries it beyond that line till it forms almost a right angle with it. The wrist joint, in this respect, differs from the other ginglymous articulations; but what it gains in extension it loses in flexion, as it cannot be bent so much as either the elbow or knee. The arrangement, however, gives great facility to the use of the hand.

In the lateral inclinations of the hand, the capsule in front of and behind the wrist is but little affected; but the lateral ligaments are alternately relaxed and tightened. As the articular surfaces are extensive in the line of these motions, dislocations in the direction of either of them are very uncommon, and when they do occur they are for the most part incomplete.

Circumduction is produced by a regular succession of the motions described; it, therefore, does not require a specific notice.

Of the Partial Motions of the Hand.—Well marked changes of position occur between the first and second rows of the carpus; these are principally flexion and extension. Lateral inclination or abduction and adduction are extremely limited, and circumduction does not exist.

The motions, such as they are, are confined within much narrower limits than those of the radio-carpal articulation, and have for their main fulcrum the head of the magnum.

The lateral articular surfaces of the several bones of the carpus, though they present the arrangement of joints, have not an appreciable motion upon each other. Whatever changes of position happen among them, are probably so obscure that they never appear, except under the influence of great and sudden violence. The complexity of the mechanism of the wrist seems to have a double object in view; for ordinary circumstances of impulse and motion, the flexion and extension of the first row upon the second, as a whole, is sufficient; but when a great momentum is communicated to the structure, the number of pieces which form it, and the variety of their shapes and mode of attachment, diffuse the violence throughout the whole wrist, and generally save it from dislocation or fracture. The fracture of a single bone, excepting from gun-shot wounds, is a very unusual circumstance. I have had, however, in possession a scaphoides which was broken through transversely, and had probably been in that state for a long time, as all appearance of inflammation, at the period of my finding it, was absent, and as the fractured surfaces had become highly polished by rubbing against one another.

The pisiform bone moves with much freedom inwardly and outwardly on the cuneiform, but its motion up and down is resisted by the muscles which are attached to it. Owing to its articular cavity being insulated, and to its own remoteness, a dislocation of it, if it did occur, would interfere but little with the general uses of the hand.

The metacarpal bone of the thumb has a very free motion on the trapezium in flexion, extension, adduction, abduction, and circumduction as the result of the other four. In consequence of this variety of movement in it, of its position on a plane anterior to that of the fingers, and of a corresponding obliquity of the trapezium, the thumb can, in all cases of grasping and examining bodies, antagonize the fingers. The circumduction of the thumb resembles very much that of the wrist, or shoulder joint, though the mechanism of the articular surfaces is different. In this motion it describes a cone or circle, the anterior segment of which is larger, and performed with more facility than the posterior.

The second and third metacarpal bones are so closely bound to the carpus that their motion above is almost imperceptible; in consequence of their length, the motion is more appreciable below, but even there it is very much restricted. The fourth metacarpal bone has a limited ginglymous movement, which is sufficiently demonstrable, and the fifth has it in a considerable degree; it also admits of a sort of adduction, by which it is brought nearer to the other bone.

The first phalanges admit of flexion, extension, adduction, abduction, and circumduction by the successive performance of the others. The first phalanx of the thumb has the three last motions very much curtailed, in consequence of the necessity of great strength and stability in this joint, so as to antagonize firmly the fingers. The remaining

phalanges perform simply flexion and extension. The latter, as in the knee and elbow, rarely goes beyond the axis of the limb, whereas the former, from the extent of the articular surfaces and the particular mechanism of the joint, permits the hand to be closed and doubled.

From what has been said it will not be difficult to form a general conception of the great variety of motions resulting from the number and arrangement of the pieces constituting the upper extremity. The os humeri being the basis of them, may be presented in any direction; the bones of the fore arm may be alternately retracted or protruded, and by the revolving of the radius will permit the palm of the hand to apply itself at any point; and again, the multiplicity of simple motions of the hand and the exhaustless variety of their compounds, contribute to give to the upper extremity in man a perfection of mechanism infinitely beyond anything which can be devised by the powers of art, a sentiment cogently expressed by the late Professor Wistar, who remarked that "The human hand, directed by the human mind, is the most perfect instrument that man ever saw, or ever will see."

CHAPTER VI.

OF THE INFERIOR EXTREMITIES.

The inferior extremities are divided for each, into the thigh, the leg, and the foot. The bones are the os femoris, the tibia, fibula, patella, and a large number which enter into the composition of the foot, constituting the tarsus, the metatarsus, and the phalanges.

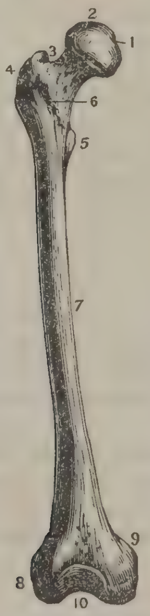
SECT. I.—OF THE THIGH BONE (*Os Femoris, Femur*).

This is the only bone in the thigh, and extends from the trunk to the leg. It is considerably the longest and largest bone in the skeleton, and presents a conformation entirely peculiar. For the purposes of description, it is divided into the two extremities and the body.

The superior or iliac extremity presents three well-marked eminences, the head, the great and the little trochanter. The head is the articular surface above, and forms rather more than one-half of a perfect sphere. Its smoothness indicates the existence of a cartilaginous crust on it during life, and is only interrupted by a small pit a little below its centre, which gives attachment to the round ligament of the hip joint. Its articular surface is more extensive above than below, as that part is chiefly employed in sustaining the trunk, and comes in contact with a corresponding surface of the os innominatum. The head is supported on a branch of the os femoris called the neck, which, projecting from the internal face of the bone, between the trochanters, is directed inwards and upwards at an angle of about thirty-five degrees, but vary-

ing in different subjects. The neck is two inches in length, oval, or resembling a flattened cone, the great diameter of which is vertical, and arises by an extensive base along the upper end of the os femoris. It has a great multitude of foramina dispersed over it, which penetrate to its interior, and give passage to blood-vessels; the largest of them are on its posterior surface. Some of these foramina are also occupied by fibres. A superficial horizontal fossa may be seen crossing the posterior face of the base of the neck; it is formed by the tendon of the obturator externus.

Fig. 63.



An anterior view of the Femur of the right side.—1. Depression for the round ligament. 2. The head. 3. The neck. 4. Trochanter major. 5. Trochanter minor. 6. Surface for the capsular ligament. 7. Shaft of the bone. 8. The external condyle. 9. The internal condyle. 10. Trochlea for the patella.

The great trochanter is situated at the superior part of the base of the neck, and though presenting a well-marked, elevated summit, rising straight upwards, does not reach the altitude of the head, but falls short of it half an inch. The trochanter major rests upon a broad base, has its surface much diversified, is somewhat prominent in front and externally; but presents on the side which is next to the head of the bone a deep round concavity (*fossa trochanterica*), which is occupied by the insertion of the small rotatory muscles on the back of the pelvis. On its summit is a small smooth spot, made by the insertion of the pyriformis muscle; below this, but externally, is a broad surface, slightly convex, into which the gluteus medius is inserted; below this, again, is a second prominent and rounded surface, over which a part of the tendon of the gluteus magnus plays. On the front of the tro-

chanter, and just in advance of the insertion of the gluteus medius, is an oblong surface, proceeding obliquely downwards and outwards, into which is inserted the gluteus minimus.

The trochanter minor is much smaller than the other, and is a conical process, placed on the internal posterior face of the bone, at the lower end of the root of the neck. It receives the common tendon of the iliacus internus and psoas magnus muscles. A broad elevated ridge joins the two trochanters on the posterior face of the bone, and into its middle half is inserted the quadratus femoris muscle. A much smaller ridge, and by no means so elevated, runs in front, from the one process to the other, and indicates the line of attachment of the capsular ligament of the hip joint.

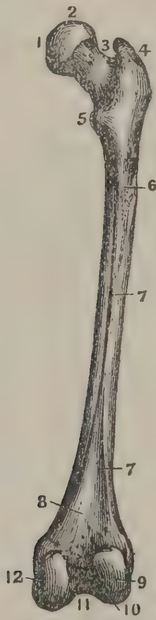
The inferior extremity of the os femoris is much more voluminous than the superior, and is divided into two parts, called the internal and the external condyle. These condyles are of very nearly the same size, but, being separated by a notch behind, they are placed somewhat obliquely in regard to each other; and the internal, from being the most oblique, and consequently the most protuberant, also seems to be the larger. If the os femoris be placed exactly vertical, the internal condyle has the appearance of being the longest; but, if placed in its natural obliquity, the lower face of the condyles is on the same plane. In front, the condyles unite to form an articular trochlea, on which the patella plays; this trochlea is unequally divided by a vertical depression, so as to have its more extensive surface external. This latter surface is the anterior part of the external condyle, and is much more elevated than the internal part of the trochlea, which belongs to the internal condyle. Posteriorly, the internal condyle projects more than the external, and both have the articular surfaces, there, so much elongated backwards and upwards, as to admit of a very great flexion of the leg. The upper posterior end of each condyle is occupied by the origin of the respective head of the gastrocnemius muscle.

Each condyle presents an internal and an external face. The internal condyle has on its internal face a tuberosity, from which proceeds the internal lateral ligament of the knee; on its external face it forms one-half of the notch which separates it from the other condyle, and at its anterior part in the notch may be observed a small depression, from which proceeds the posterior or internal crucial ligament. The external condyle, also, has on its external face a tuberosity, from which proceeds the external lateral ligament of the knee, and just below it a depression for the origin of the popliteus muscle. Its internal face forms the other half of the notch just mentioned, and on the posterior part of this face is a small depression for the attachment of the anterior or external crucial ligament. The inferior face of the condyles is somewhat flattened, the transverse diameter of that of the external being rather longer than the other. The inferior extremity of the os femoris is beset with foramina, large and small, for the passage of vessels and the attachment of fibres.

The body of the os femoris begins with the trochanters and termi-

nates in the condyles. It is slightly bent, so as to present the convexity of the curve forwards. Its size is gradually diminished to the middle; it then begins to enlarge, and continues to augment till it terminates in the large inferior extremity. The body is very nearly round, and departs from that figure only on its posterior face, where an elevated rough ridge is found occupying the superior two-thirds of the bone, and called the linea aspera. The linea aspera begins broad,

Fig. 64.



A posterior view of the Femur of the right side.—1. Depression for the round ligament. 2. The head. 3. Depression for some of the rotatory muscles. 4. Trochanter major. 5. Trochanter minor. 6. Roughness for the gluteus magnus tendon. 7, 7. The linea aspera. 8. Flat surface above the condyles. 9. The external condyle. 10. Depression for the anterior crucial ligament. 11. Depression for the posterior crucial ligament. 12. Point of origin of the internal lateral ligament.

rough, and flat, on a level with the trochanter minor; it narrows as it descends, and becomes, at the same time, more elevated. In the whole course of the linea aspera, an internal and an external margin are very obvious. Its lower extremity bifurcates, about four or five inches above the condyles, into two superficial, slightly-marked ridges, one on each side, which may be traced into the posterior extremity of its corresponding condyle. Between these ridges the surface of the bone is flattened. The superior half of the external margin of the linea aspera is marked by the insertion of the gluteus magnus, and the remainder of the same margin, by the origin of the biceps flexor cruris. This margin also gives origin to the vastus externus. The internal margin of the linea aspera and its continuous ridge are mostly occupied by the insertion of the triceps adductor, and by the origin of the vastus internus.

In the linea aspera, in the upper part of the middle third of the bone, is the canal for the nutritious artery, which slants upwards:

occasionally one or more canals besides are found in it for the same purpose.

The texture of the os femoris is compact in its body. Its extremities are cellular, with the exception of a thin lamina forming their periphery; the cylindrical cavity in its middle, like that in all the other long bones, is reticulated. The ossa femorum approach each other very closely at their inferior extremities, but are widely separated at their superior in consequence of the length of their necks, and of the distance of the acetabula from one another.

SECT. II.—OF THE LEG.

Two bones form the leg, the tibia and the fibula, to which may be added the patella, from its attachment to the tibia.

Of the Tibia (Tibia).

The tibia is placed at the internal side of the leg, and extends from the thigh to the foot. After the os femoris, it is the longest and the largest bone in the skeleton. It is divided into the body and the two extremities.

The superior extremity of the tibia is oval transversely, and presents an extent of surface suited to the articular face of the two con-

Fig. 65.

An anterior view of the Tibia of the right side.—1. Spinous process and pits for the attachment of the crucial ligaments. 2, 4. Surface for the condyles of the femur. 3. Projection for the head of the fibula. 5. The tubercle. 6, 6. The spine and shaft of the bone. 7. Internal malleolus. 8. Process for the internal lateral ligament of the ankle. 9. Tarsal surface. 10. Face for the lower end of the fibula.

dyles of the os femoris, to which it is joined. It has here two superficial cavities for receiving the ends of the condyles; one of them is internal, and the other external. The internal is the deeper and more extensive of the two, and, being oval, has its long diameter in an antero-posterior direction. The external, besides being smaller and more superficial, is more circular; and, from the want of elevation in its margins, scarcely presents at all the appearance of a cavity. These two cavities, which approach to within half an inch of each other, are kept entirely separated by an elevated triangular ridge, with a broad base, called the spinous process of the tibia. The summit of the ridge presents two tubercles, one at each end, separated by a pit which serves to attach the posterior end of the external semilunar cartilage. The ridge is placed nearer the posterior than the anterior margin of the tibia. Its base, in front, is depressed for the attachment of the anterior crucial ligament, and just before this is a rough, triangular space, extending to the anterior margin of the bone and covered by fat in the recent subject. Between the ridge and the posterior margin of the bone, is a deep depression for the attachment of the posterior crucial ligament.

The circumference of the superior part of the tibia, just below its articular surface, is flat before, somewhat flat and concave behind, and bulging at the sides. The flatness, in front, is triangular, having its base upwards and the apex downwards; the latter terminates in a well-marked, broad, rough rising, which is the tubercle of the tibia, and serves for the insertion of the tendon of the patella. The concavity behind is made by the popliteus muscle, and slopes from above obliquely inwards and downwards. The projection is large on the internal side of the upper extremity of the tibia, and at its internal posterior part has a depression made by the insertion of the semi-membranosus tendon. The external projection is thicker in front than behind; at the latter point it has a small articular face, looking downwards, for the head of the fibula.

The inferior extremity of the tibia is much smaller than the superior. It is terminated by a transverse quadrilateral cylindrical cavity, by which it articulates with the astragalus. This concavity is narrower and deeper internally, than externally, and is traversed from before backwards by a low broad elevation. It is bounded internally by the internal ankle (*malleolus internus*), a large process of half an inch in length, the external side of which is a continuous surface with the cylindrical concavity, and forms part of the joint. The other side of the malleolus is superficial, being just beneath the skin. A shallow groove exists in its posterior part, which transmits the tendon of the tibialis posticus and of the flexor longus digitorum pedis. Inferiorly, the malleolus is notched, or presents a depression, for the origin of the internal lateral ligament, and just before the depression it is elongated into a point. The lower end of the tibia presents, before and behind, a slight swell, running transversely just above the articular surface. The posterior swell is occasionally slightly marked by the tendon of the flexor longus pollicis pedis.

Externally, the circumference of the lower end of the tibia presents, longitudinally, a rough concavity which is in contact with the lower end of the fibula. This concavity terminates insensibly above, but is deep below, where it is bounded before and behind by an elevated point of bone, of which the posterior is the higher. The concavity is placed nearly in the vertical line of the little articular face for the fibula, on the head of the tibia; and at its lower margin, there is frequently a small lunated surface, which is continuous with the articular surface for the astragalus, and is consequently a part of the cavity of the ankle joint. Just above this lunated surface the bone is rough for the origin of short ligamentous fibres, which unite it to the fibula.

The body of the tibia commences just below the enlarged upper extremity, and terminates near the ankle. In the front view of it, it diminishes continually in descending, in its superior two-thirds: afterwards it enlarges gradually to the lower extremity; in the lateral view it diminishes downwards almost to the lower extremity. It is slightly bent forwards, and is generally prismatic, more particularly above; one of its faces is internal, another external, and the third posterior. The internal face is rounded, and, with the exceptions of its upper part, where the flexor tendons are inserted, it is covered by the skin only. Its external face is flat, excepting below, where it is rounded and is covered by the muscles on the front of the leg. The posterior face is slightly rounded, except at its upper part where it is crossed by a line running obliquely from the articular surface for the fibula, downwards and inwards: above which line, is the superficial triangular depression for the popliteus muscle.

The three sides of the tibia are marked off from each other by ridges of bone. The anterior ridge, called the spine or crest (*crista*), begins at the external margin of the tubercle for the insertion of the tendon of the patella, and may be traced very distinctly, in the form of an S very slightly curved, almost to the malleolus internus: it is more elevated in its middle. The external ridge is a straight line running from one extremity of the bone to the other; to it is attached one edge of the interosseous ligament. The internal ridge is rounded, but also runs the whole length of the body of the bone, being more distinct below. The internal lateral ligament of the knee and the soleus muscle are attached to it, above; and the flexor longus digitorum pedis, below.

Foramina large and small, for blood-vessels and fibres, are found on the circumference of both extremities of the tibia. On its posterior face, about one-fourth of its length from the head, is a large canal sloping downwards, through which passes the nutritious artery. Its structure, like that of the other long bones, is cellular at its extremities; but compact in the body, where it presents a cavity occupied by cancellated matter. It will now be understood how it articulates with the fibula, externally at both ends; with the os femoris above; and with the astragalus below.

Of the Fibula (Péroné).

The fibula is placed at the external side of the tibia, and extends from the head of the latter to the foot: it is much smaller, and not quite so long as the tibia, and is so articulated with it as to be on a line with its posterior face. It is to be studied in its two extremities and in its body.

Fig. 66.

An anterior view of the Fibula of the right side. 1, 2. Articular face for the tibia. 3. Point of insertion of the external lateral ligament. 4. Shaft of the bone. 5, 5. External face, for the peroneus primus and secundus muscles. 6. Interosseous ridge. 7. Face for the lower end of the tibia. 8. Malleolus externus.

The upper extremity of the fibula is considerably enlarged and irregular. It presents, above, a small articular face directed upwards and very slightly concave, by which it joins the corresponding face of the tibia. This surface is bounded behind by a sort of styloid process, into which is inserted the tendon of the biceps flexor cruris. The circumference of the bone, in advance of this, furnishes attachment to the external lateral ligament of the knee.

The inferior extremity of the fibula is also enlarged, being flattened on its tibial side, but more rounded externally. This part of the fibula is called the external ankle (*malleolus externus*). It descends lower than the internal ankle, and is also more prominent and large. Its tibial side presents, below, a small triangular, slightly convex articulating surface, which is against the side of the astragalus; behind, and somewhat below it, is a small rough excavation, which, with the adjoining inferior margin of the bone, gives origin to the three fasciculi of the external lateral ligament of the ankle. Above the articular surface,

the bone is rough and slightly rounded where it is received into the side of the tibia, and sends off many short ligamentous fibres to it. The anterior margin of this extremity of the fibula is thin and projecting; the posterior surface is flat and broad, and is slightly scooped out into a longitudinal groove, which transmits the tendons of the two peronei muscles. The pointed termination below, of the malleolus externus, is sometimes called the coronoid process.

The body of the fibula extends between its extremities. It is irregularly triangular, somewhat smaller above than below, thick posteriorly, thin anteriorly, and slightly convex in its length behind.

There are three faces to the fibula, one is external, another internal, and the third posterior. The first is semi-spiral, and turned forwards above; its superior third gives origin to the peroneus primus muscle, and the middle third to the peroneus secundus; its lower third exhibits the semi-spiral arrangement which may be traced into the groove on the posterior part of the malleolus externus, and thereby indicates the course of the tendons of these peronei muscles. The internal face is directed towards the tibia; it is divided by a low longitudinal ridge into two parts, of which the anterior is the narrower. The ridge itself, well marked in the middle two-fourths of the bone, is indistinct above and below, and furnishes attachment to the interosseous ligament. The space in front gives origin to the extensor proprius pollicis, and the extensor communis digitorum: and the space behind gives origin to the tibialis posticus. The posterior face is also somewhat semi-spiral, its superior end being outwards, and the inferior end inwards. The superior third gives origin to the soleus muscle, and the remainder to the flexor longus pollicis pedis.

The angles of the fibula, which are formed by the junction of the three surfaces described, differ somewhat among themselves. The anterior angle is frequently very sharp and elevated in its middle half, and below it bifurcates into two ridges, including between them a triangular space above the external ankle, and which is covered by the integuments only. The posterior angle is well marked, and winds so as to be external above, and posterior near the foot. The internal angle, formed by the union of the internal and the posterior surfaces, is only very well marked in its middle half. The projection of this angle gives to the bone the appearance of inclining inwards towards the tibia, besides which it has actually a little bend in that direction.

Near the middle of the posterior face of the fibula, a canal, sloping downwards, conducts the nutritious artery. The circumference of the extremities, like that of the other long bones, presents a multitude of foramina for vessels and the filaments of fibres to pass. It is composed in its extremities of cellular or spongy structure, and in its body of compact matter, enclosing a cavity occupied by cancellated structure.

Of the Patella (Rotule).

The patella is a small bone, intermediate to the thigh and to the leg, and placed on the fore part of the knee joint; it is smaller in proportion in females than in males.

Its anterior face being uniformly convex, is rough and studded with a considerable number of foramina for the passage of vessels, and for the attachment of fibres. The course of the longitudinal ridges com-

Fig. 67.

An anterior view of the Patella.—1, 2. Surface for the quadriceps femoris tendon. 3. Lower extremity and point of origin of the ligamentum patellæ.

posing the front of the bone is well marked. The posterior face of the patella is an extensive articular surface, divided unequally by a broad longitudinal elevation, which runs from the superior to the inferior margin of the bone. The part of this surface external to the ridge is the largest and the most concave, and is applied to the trochlea, in front of the external condyle of the os femoris; while the smaller surface is on the internal side of the ridge, and is applied to the trochlea of the internal condyle.

The circumference of the patella is nearly oval, the long diameter being transverse. Its thickness is much augmented above, where it presents a rough and somewhat unequal flatness for the insertion of the tendon of the rectus femoris. Below, the bone is thinner, and elongated into a conical point, from which proceeds the tendon of the patella to be inserted into the tibia. Laterally, the margins are thinner still.

The texture of the patella is cellular, covered by a lamina of condensed bony matter. It is developed in the tendon of the extensors of the thigh, and with the exception of its posterior face, remains in a state almost entirely cartilaginous, for a year or two after birth. In its fracture, union is effected more frequently by the fibrous base alone, than by perfect ossification. To put it into its proper position, turn the point downwards, and apply the greater surface behind, to the trochlea of the external condyle. The patella is said to be to the tibia what the olecranon is to the ulna; and is, therefore, a sort of appendage to it, united by ligament instead of being continuous with it, as is the case with the olecranon.

SECT. III.—OF THE FOOT.

The foot forms the third portion of the inferior extremity, and is placed at a right angle to the bones of the leg. The size of its bones varies much in different individuals, depending largely upon their modes of life and dress; it also varies considerably in the two sexes, being, for the most part, smaller in proportion in the female. The foot is oblong, narrower behind than before; presents one surface above, which is its back, and another below, which is the sole; a posterior extremity called the heel, and an anterior extremity called the point. Its internal margin is much thicker, longer, and more concave than the external margin.

The foot is divided into Tarsus, Metatarsus, and Toes, or Phalanges.

Fig. 68.

A view of the upper surface of the Left Foot.—1. The astragalus on its upper face. 2. Its anterior face, articulating with the naviculare. 3. The os calcis. 4. Naviculare, or scaphoides. 5. The internal cuneiform. 6. The middle cuneiform. 7. The external cuneiform. 8. The cuboid bone. 9. Metatarsal bones. 10. First phalanx of the big toe. 11. Second phalanx of the big toe. 12 12, 13 13, 14 14. The first, second and third phalanges of the other toes.

Of the Tarsus (Tarse).

The tarsus forms the posterior half of the foot, and is composed of seven distinct bones, which are arranged on a plan, and present features having scarcely a single point of resemblance with the carpus. These bones are, the Os Calcis, the Astragalus, the Naviculare or Scaphoides, the Cuboides, the Cuneiforme Externum, Cuneiforme Medium, and Cuneiforme Internum.

Of the Os Calcis (Calcaneum).

The os calcis, or heel bone, forms, almost exclusively, the posterior half of the tarsus, and may be readily distinguished by its greater magnitude. Its shape is very irregular. Its greatest diameter is in the length of the foot; it is also thicker vertically than transversely.

The superior face is deeply scooped out at its fore part, and is formed there into two articular surfaces, for joining with the astragalus: these faces are separated by a rough fossa, which runs from within obliquely forwards and outwards, and accommodates a ligament. The anterior external part of this fossa is deep, broad and triangular; the posterior part is narrow, is occupied by a ligament, and allows the two articular surfaces to come nearer. Just behind the fossa is the first articulating surface, lying parallel with it; being oblong, convex, semi-cylindrical, and looking obliquely upwards and forwards. Before the fossa is the second surface: it is oblong, much smaller than the first, and is very frequently divided into two by a transverse notch, and is concave. The part of the bone upon which this face is wrought, is called, by the French, the little apophysis. I have frequently remarked, that the face posterior to the first-mentioned fossa, is smaller and more vertical in the African than in the European; the os calcis, behind it, is also smaller and longer. The upper posterior face of the bone is somewhat concave.

The under surface of the os calcis is slightly concave, longitudinally. It is bounded, behind, by two tuberosities, of which the internal is larger than the external; they both give origin to muscles of the sole of the foot and to the aponeurosis plantaris. There is also a tuberosity bounding the same surface in front, from which arise the ligaments that connect this bone with the adjoining ones.

The anterior extremity of the os calcis forms the greater apophysis, and is terminated in front by a triangular semi-spiral concave surface, by which it articulates with the os cuboides. The posterior extremity is convex and rough: constitutes the heel, and near its middle receives the tendo-Achillis; above this the surface is sloping and more smooth, in order to accommodate this tendon in the flexions of the foot.

The external surface of the os calcis is flat, with the exception of a gentle rising in its middle; it is marked, occasionally, by a superficial groove, indicating the course of the tendons of the peronei muscles. The internal surface is very concave, and obtains the name of sinuosity; along it pass the tendons of several muscles from the back of the leg, of which that of the flexor longus pollicis pedis makes a conspicuous groove on the under surface of the little apophysis, at its base. The point of the apophysis makes a trochlea for the tendon of the tibialis posticus.

Of the Astragalus (L'Astragale).

This is the next in size to the os calcis, and is placed on the superior part of the latter, between it and the bones of the leg.

The astragalus presents, above, a projecting semi-cylindrical surface, by which it is put in contact with the tibia. This surface is narrower, and continued farther behind than it is before; is slightly depressed, longitudinally, near its middle, and, consequently, presents an elevated margin on either side, of which the external is the broadest and highest. This articular face continues on each side of the bone, and is more extensive externally, where it comes in contact with the fibula or malleolus externus, than internally, where it touches the malleolus internus.

The inferior face of the astragalus is traversed by an oblique rough fossa, going from within outwards and forwards, and corresponding in size and appropriation with that on the upper face of the os calcis. Behind the fossa, and parallel with it, is a deep oblique semi-cylindrical cavity, suited to the adjoining face of the os calcis; and before the fossa is a narrow oblong projection, suited to the corresponding articular cavity of the same bone. When this concavity is divided into two facets, the projection of the astragalus presents also two facets, separated by a small ridge.

The anterior extremity of this bone is terminated by a hemispherical head, the horizontal diameter of which is the longer. This head articulates with the scaphoides, and is continuous with the surface that rests upon the little apophysis of the os calcis. On the internal side of the head is a small triangular surface, continuous with the others, that rests upon the strong ligament going from the os calcis to the scaphoides. Above, immediately before the surface for the tibia, is a small depression, which, in the flexions of the foot, receives the anterior margin of the articular surface of that bone. The posterior extremity of the astragalus is thin, and has a notch, or groove formed in it by the tendon of the flexor longus pollicis pedis.

Of the Naviculare, or Scaphoides (Scaphoide).

It is situated at the internal side of the tarsus, between the astragalus and the cuneiform bones, and has its longest diameter transverse. Its circumference is oval, thicker above than below, and its internal side presents a large tuberosity; into which is inserted the tendon of the tibialis posticus. Sometimes the external margin has a small articular face, where it comes in contact with the cuboides.

The scaphoides presents, behind, a deep cavity, which receives the head of the astragalus; anteriorly, it is somewhat convex, but this surface is divided by small ridges into three triangular faces, for the three cuneiform bones. Of these faces the internal is broader below than above; the others are broader above than below.

Of the Cuboides (Cuboide).

It is situated at the external side of the tarsus, between the os calcis and the metatarsal bones. Its figure is irregular, but, perhaps, sufficiently indicated by its name. It is narrower externally than internally, and has the posterior extremity oblique.

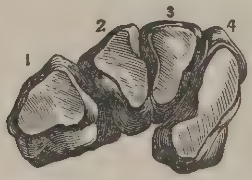
The superior face of the cuboides is rounded, but rough. The inferior face has in its middle a broad elevated ridge, running almost transversely, but somewhat forwards. The external extremity of this ridge is marked by a trochlea, on which plays the tendon of the peroneus longus; the tendon is then conducted along a groove between the ridge and the anterior margin of the bone.

The internal face is flat, and has in its middle a circular face, where it comes in contact with the cuneiform externum. The posterior face joins the os calcis, is triangular, and semi-spiral. The anterior face is oblong, transverse, and is divided by a slight vertical rising into two, for articulating with the two outer metatarsal bones.

Of the Cuneiforme Internum (Premier Cunéiforme).

It is placed at the internal anterior extremity of the tarsus, between the scaphoides and the first metatarsal bone, and may be distinguished from the other cuneiforms by its greater size. Its thickest part is below.

Fig. 69.



An anterior view of the three Cuneiform Bones, and also of the Cuboid of the right side.—1. The cuboid. 2. The cuneiforme externum. 3. The cuneiforme medium. 4. The cuneiforme internum.

The anterior face presents a long vertical rising, which joins the first metatarsal bone. The posterior face is not so extensive, and is formed into a triangular cavity, having the broadest part below, and which joins the internal facet of the scaphoides. The internal side is semi-cylindrical and rough; it is marked, at its inferior anterior part, near its middle, by the tendon of the tibialis anticus. The external side is somewhat concave, and generally rough, and is marked just below its superior margin by two articular facets, of which the anterior is the smaller, and comes in contact with the second metatarsal bone; the posterior, from its concave obliquity, gives a slope to the upper margin of the bone, and is in contact with the cuneiforme medium.

Of the Cuneiforme Medium (Seconde Cunéiforme).

The middle or second cuneiform bone is placed upon the scaphoides, immediately on the outside of the cuneiforme internum. It may be distinguished by being the smallest bone of the tarsus. Its figure resembles sufficiently well a wedge, the base of which is above, and the edge below.

Its posterior face is slightly concave where it joins the scaphoides; the anterior face is slightly convex, and articulates with the second metatarsal bone. The internal face presents, superiorly, an oblong, slightly convex, oblique articular facet, which touches the cuneiforme internum; what remains of this side, being below, is rough, for the origin of ligamentous fibres. The external face is uneven, and presents, at its posterior part, a vertical articular face for joining the cuneiforme externum; but, anteriorly, it is rough for the origin of ligamentous fibres.

In the articulated foot the lower part of this bone is almost concealed between the other two cuneiforms.

Of the Cuneiforme Externum (Troisième Cunéiforme).

The external or third cuneiform bone is placed upon the scaphoides, between the second cuneiform and the cuboides. Of the three cuneiform bones, it is the second in size, and is also appropriately named from its shape. The base is upwards.

The posterior face furnishes, on its superior half to join the scaphoides, a quadrangular articular facet, sloping outwardly, below which the bone projects into the sole of the foot. The anterior face is flat, and articulates with the third metatarsal bone. The internal face presents, above, two articular facets, of which the one at the posterior end is larger than the other, and joins the second cuneiform; the other, at the anterior end, is very small, and touches the second metatarsal bone. Below these facets the bone is rough, and gives origin to ligamentous matter. The external face, at the middle, forms an angular projection, behind which is a small oval articular surface that joins the cuboides. The remainder of this face is rough, for the origin of ligaments, with the exception of a very small articular facet at the anterior superior corner, which joins the fourth metatarsal bone.

The structure of the bones of the Tarsus is uniformly cellular within, the cells being enclosed by a thin lamina of condensed matter. The astragalus is rather stronger and more compact than any of the others. I have seen one instance, however, in which it had been separated into two pieces by a transverse vertical fracture, going from the ankle joint to the articulation with the os calcis. The observation was made after it had been boiled; the callus had completely united the two fragments, and no displacement had occurred.

If a vertical section of the os calcis and of the astragalus be made, the parietes of the cells are found to radiate from the upper articular surfaces like columns, so as to prevent the bones from being crushed by the vertical weight of the body.

Of the Metatarsus (*Metatarse*).

The metatarsus succeeds to the tarsus, and is formed by five long parallel bones like the metacarpus. They are called numerically, beginning on the inner side, or that of the great toe. There are four intervals between them, which are filled up by the interosseous muscles. The posterior end is the base, and the anterior the head. The base is large and triangular; the head is a hemisphere compressed from side to side. The body is flattened, laterally, by the pressure of the interosseous muscles.

Of the First Metatarsal Bone.

Placed at the inner side of the foot upon the cuneiforme internum, and forming the base of the great toe, it may be readily distinguished in the separated bones by its greater size and its shortness.

The posterior extremity presents an oblong articular concavity, the greatest length of which is vertical, for joining the cuneiforme internum. The internal semi-circumference of this extremity is protuberant, while the external is slightly concave or flat, it presenting below a prominent tubercle, into which is inserted the tendon of the peroneus longus, and frequently there is above a facet, where it articulates with the base of the second metatarsal.

The anterior extremity, or the head, is rounded and convex, forming an articular surface for the first phalanx of the great toe. This surface is continued far back below, and presents there, for the sesamoid bones, a trochlea with a longitudinal ridge in its middle. The lateral surfaces of the head are rough and concave, for the origin of the lateral ligaments.

The body is much smaller than the extremities, and is prismatic. Its internal side is rounded, the external side flattened, and the inferior side concave, longitudinally, for lodging the muscles of the great toe.

Of the Second Metatarsal Bone.

This is the longest of any, and may be distinguished from the others principally by that circumstance.

The posterior extremity is prismatic, the base being above. It presents a surface very slightly concave, almost flat, which rests upon the cuneiforme medium. The sides of this extremity being flattened laterally, it is locked in between the internal and external cuneiforms; on its internal side, above, is an articular facet, where it comes in contact with the cuneiforme internum and first metatarsal; and, externally,

above, it has two articular facets. The posterior one of the latter touches the cuneiforme externum, and the anterior, which is smaller, comes in contact with the third metatarsal bone. These two facets run together by an angular rising.

The anterior extremity is prominent and rounded; its vertical diameter is more considerable than its transverse, and the articular face which it furnishes to the second toe is continued considerably below, in order to assist the flexion of the first phalanx. Its circumference is rough, and flattened laterally for the origin of the ligaments.

The body is smaller than either of the extremities, and decreases gradually from behind forwards. It is flattened on each side, and elevated longitudinally above and below, into a ridge. There is a curvature in its length, which makes it bowed above, and concave below, for the lodging of muscles.

Of the Third Metatarsal Bone.

This is rather shorter than the second, but has very much the same shape.

Its posterior extremity, or base, is wedge-shape, having the base above, and the edge below, which is not so sharp as the preceding. It articulates with the third cuneiform; the surface for the latter slopes outwardly. Its superficies is flattened laterally, and presents, internally, at its posterior corner, a small face, which articulates with the second metatarsal; externally, it also presents, at its superior corner, an articular facet, which joins the fourth metatarsal.

Its body and anterior extremity do not present any essential points of difference from the second metatarsal.

Of the Fourth Metatarsal Bone.

It is somewhat shorter than the third, and is placed upon the internal of the two anterior faces of the cuboides.

The posterior extremity, or base, is more an oblong than the base of the preceding bones, and has somewhat of a bent condition. It presents an articular face to the cuboides, and which is also square or nearly so, flat, and slopes outwardly. On its sides it is irregular; internally, at the superior margin, it has two articular facets, continuous with each other, but forming thereby an obtuse angle; the anterior joins the third metatarsal; and the posterior, which is much the smaller, touches the cuneiforme externum. Below these, the surface is rough. The articulation with the cuneiforme externum is occasionally deficient. I have observed the latter, particularly in the negro, and it seems to arise from the unusual development of the cuboides. The external surface of the base has at its superior corner an articular facet for the

fifth metatarsal bone, and below it an oblique deep fossa, before which is a tubercle.

The anterior extremity and the body of this bone, though smaller than those of the preceding, do not present any essential points of difference.

Of the Fifth Metatarsal Bone.

This is shorter than any of the others, excepting the first, and is placed on the front of the cuboides, externally.

Its base is remarkable, and distinguishes it strongly, by being projected considerably beyond the external margin of the cuboides, and forming there a large tubercle, into the superior part of which is inserted the tendon of the peroneus tertius, and into the posterior part, the tendon of the peroneus secundus. The base, also, has a triangular flat surface, sloping considerably outwards, which articulates with the cuboides. On the internal side is the articular facet, whereby it joins the base of the fourth metatarsal bone. The base is flattened below, rough, and somewhat convex above.

The anterior extremity is more rounded than that of the other metatarsal bones, but in other respects similar. The body is prismatic; being flat below, flat internally, and slightly rounded externally.

Of the Toes.

The toes are five in number, and named numerically, by beginning at the great one. They each are formed by three bones called the phalanges, with the exception of the great toe, which has but two of them. The phalanges are distinguished into first, second, and third. In these several respects the toes correspond with the fingers. (See Fig. 68.)

Of the First, or Great Toe.

The first phalanx of the great toe is longer and much larger than any other. Its base is large, and forms a deep concavity for receiving the end of the first metatarsal bone. Its anterior extremity is formed into two small condyles, for being received into the second phalanx. This bone is broad and strong, being semi-cylindrical above, and flat below.

The second phalanx is very much like the second phalanx of the thumb, and corresponds with the third of the other toes, but is much larger than any of them. Its base is broad and flat, and has two superficial cavities for the condyles of the first phalanx. The anterior extremity is expanded semicircularly, and converted into a very scabrous surface, for the firmer attachment of the soft parts about it. The body of this phalanx is constricted in the middle, rounded above, and flat below.

Connected with the great toe, are two small hemispherical bones, lying upon the trochlea of its metatarsal bone, and imbedded in the tendons of the small muscles which move the first phalanx. They are the sesamoids, and present, superiorly, an articular surface, covered with cartilage, which enters into the composition of the joint; and below, a rounded surface, which has nothing remarkable.

The sesamoid bones, though generally appropriated to this joint, and to the corresponding one of the thumb, are yet occasionally found elsewhere. For example, in the second joint of the same toe; in the first joint of the other toes; in the first joint of the fingers; in the knee joint, behind each condyle; and, in advanced life, in tendons where they slide upon bones. Ancient luxations give a disposition to their development in the capsular ligaments of the ginglymous joints, of which very interesting specimens may be seen in the Anatomical Museum.

Of the Smaller Toes.

Their phalanges bear a general resemblance to those of the fingers, but are much smaller and shorter.

The first phalanges are successively diminished to that of the little toe, and are almost precisely like each other. Their posterior extremities, or bases, form a cavity deeper in proportion than in the fingers, for receiving the ends of the metatarsal bones. The anterior extremities are fashioned into two small condyles for forming a hinge-like joint with the second phalanges. The bodies are smaller than the extremities, more rounded and narrower than in the fingers.

The second phalanges are very short, the extremities being so near each other that the body is of inconsiderable length, particularly as regards the last two, where it forms a mere line of separation. The posterior end has two superficial cavities for receiving the first phalanx; the anterior end is imperfectly fashioned into two little condyles for joining the third phalanx.

The third phalanx has a well-formed articular surface for joining the second. The anterior extremity is rough, for the attachment of the adjoining soft structure. This phalanx of the fourth and fifth toe is frequently very imperfectly developed, being a mere tubercle with an articular face at one end.

The structure of the metatarsal and phalangial bones resembles that of the other long bones. Porous and cellular at the extremities, their bodies are composed of compact lamellated matter, enclosing a cancellated texture.

SECT. IV.—OF THE DEVELOPMENT OF THE INFERIOR EXTREMITIES.

The comparatively small quantity of blood which is sent to the lower extremities of the fœtus is the cause of their not being so large in pro-

portion to the upper, at the time of birth, as they are subsequently. Our wants immediately after birth, and during the first months of life, are naturally such as to require but little service from the lower extremities, in which is seen a striking correspondence between the internal arrangements of the animal economy and its actual necessities; or, in other words, a continued and rigid adaptation of means to produce a certain effect.

The os femoris at birth presents several peculiarities. Its superior extremity being in a cartilaginous state, is placed more at a right angle to the body of the bone than it is in the adult. The neck is short, which by diminishing the base of support to the trunk makes the progression of infants more tottering and infirm. The lower extremity is also cartilaginous and large. The body of the bone has but a very slight degree of curvature, which likewise increases the difficulty of standing and walking in very young subjects. The patella is cartilaginous.

In the leg the bodies of the tibia and fibula are ossified, but their extremities are cartilaginous. The bones of the tarsus, with the exception of parts of the os calcis and of the astragalus, are cartilaginous. The metatarsus and the phalanges are ossified in their middle, but cartilaginous at their extremities: their development is not so complete as that of the corresponding bones of the hand.

About the fifteenth year, the bones of the lower extremities have very nearly the same forms as in the adult. They are all fully ossified, with the exception of their extremities not being fused or joined to their bodies, but still in the state of epiphyses; and, therefore, separable either by boiling or long-continued maceration. Exclusively of this condition, which sometimes remains to the twentieth or twenty-fifth year, the epiphyses are as fully ossified as at any subsequent period of life.

SECT. V.—ON THE MECHANISM OF THE INFERIOR EXTREMITIES IN REGARD TO STANDING.

The os femoris is well adapted by its shape and position to the erect attitude. The curvature which its body makes in front has the effect of advancing the lower part of it, and thereby keeping it in a line with the centre of the trunk; but if it had been perfectly straight, the erect position would have been maintained with great difficulty, owing to the centre of the trunk being in advance of this bone. Under the latter circumstances, an incessant tendency to fall forwards would have manifested itself, which could have been obviated only by flexing the ossa femorum very much at the hip joint, or by keeping one foot always in front of the other. Even under the actual arrangement of the skeleton, when muscular support is withdrawn from it suddenly, it falls forwards, owing to the weight of the parts anterior to the spine being greater than that of the parts posterior to it. When muscular action is weakened or badly regulated, the same tendency to fall forwards is manifested; children continually tumble in that direction: a

person in a state of intoxication, somewhat short of the entire loss of locomotion, not being able to sustain the trunk of the body erect by the muscles of the back, inclines forwards, and would be precipitated to the ground, were it not that at this crisis one leg is automatically advanced, so that the base of support is much augmented. But if the individual attempt to walk, the continued necessity of keeping a large basis of support to prevent the body from falling forwards, urges him into a slow running or trotting gait.

The arrangement of the whole upper extremity of the os femoris is also highly favorable to the erect attitude and to locomotion. The neck of the bone, by its length and oblique position in regard to its body, enlarges transversely the base of its support, and gives great stability in preventing the trunk from falling either to the right or left; while it contributes at the same time to the facility of progression, in permitting the os femoris to bend forwards and backwards. The lateral or transverse extent of the base, thus obtained, cannot be supplied with equal effect in any other way, as a certain proportion between the diameters of the pelvis and the length of the neck of the thigh bone is indispensable. In females, where the transverse diameter of the pelvis is greater than in males, though standing is equally secure as in the latter, yet their progression is always marked by a want of firmness strongly characteristic of the sex. The strength of the articular connection of the os femoris with the innominatum is confirmed by the acetabulum being placed where the latter is reinforced by the linea-ilio pectinea, and by the anterior inferior spinous process; and as the principal weight of the trunk is sustained by the acetabulum, immediately below the latter process, we accordingly find it at this point of the greatest depth. It is also to be stated, that the capsular ligament at this part is stronger than elsewhere, thereby conforming strictly to the general purposes of the articular connection. The capsular ligament is assisted by the ligamentum teres, which, by arising from the lower margin of the acetabulum and passing upwards to the head of the os femoris, prevents the head from sliding upwards, while it permits it to swing freely backwards and forwards in its socket.

In erection, the bones of the leg are in a line with the vertical diameter of the trunk: in this respect they differ very materially from the os femoris, which not only inclines forwards in its descent, but also leans towards its fellow internally, and almost touches it at the knee. This relative position of the leg and thigh is obtained by the greater length of the internal condyle of the os femoris, and also by the other peculiarities of form in the latter; whereas the tibia is nearly straight in the direction of its long diameter, and has a horizontal articular surface above, whereby it and the os femoris make an entering angle externally and a salient one internally. Under common circumstances, the weight of the trunk is transmitted to the foot exclusively through the tibia, owing to the fibula not entering into the composition of the knee-joint, and not being sustained by any bony basement at its inferior part. The fibula is principally intended for the origin of muscles, and for the

lateral security of the ankle joint, and may be broken without the accident suspending either erection or locomotion.

The position and shape of the foot concur largely in the general object of maintaining the human being in the erect attitude. Fixed at a right angle to the leg, and articulated by a surface in the centre of its most solid structure, the tarsus, it receives the weight of the body perpendicularly upon the astragalus. The latter being the keystone to the arch, diffuses the pressure through the remainder of the structure, so that the whole foot is planted against the ground, an attitude more fully executed by man than by any other animal. The tendency of the body to fall forwards requires a very considerable elongation of the foot in front of the tarsus, in order to increase the extent of the base of support in that direction. We accordingly find the metatarsal bones not only forming bases for the flexion of the phalanges; but also by their great length, by the flatness of the articular faces which they present to the tarsus, and by their consequent immobility at these points, extending and securing the base of the body in that direction to which its gravitation most inclines it. The first metatarsal bone, though corresponding in place with the first metacarpal, is very unlike it in other respects. Of predominating magnitude, but parallel with the other bones and immovable at its base, it is obviously intended for sustaining the body, and least of all for prehension and for antagonizing the other bones, as is the case with the thumb.

The points on which the foot is particularly pressed when we stand, are the tuberosities of the os calcis, the tuber of the base of the last metatarsal bone, with the under surface of the cuboides, and the anterior extremity of the first metatarsal bone. The arch of the foot, upon which this depends, may be considered in two ways: one is in the longitudinal direction, and has its abutments in the os calcis behind, and in the ends of the metatarsal bones in front; the other is transverse, is but slightly elevated externally, indeed almost flat, while it is raised to a considerable height internally. This double arrangement is eminently serviceable in many respects: it permits a concavity in which the muscles of the toes may repose and act without being pressed upon by the superincumbent weight of the body—it also permits a free flow of blood and of nervous energy to this structure, gives a very elastic base to the whole body, and allows itself to be applied to such inequalities of surface as it meets with.

It has been agitated, by some ingenious inquirers into the original condition of man, whether the erect attitude is natural to him and not the result of an advancement in civilization. Independently of the proofs derived from the authentic reports of travellers concerning the varieties of the human family, from none of whom have we reason to believe that the latter have anywhere been found adopting habitually the attitude of quadrupeds; there are evidences derived from the general mechanism of the skeleton, still more conclusive, that standing is fully natural to us. For example: 1st. The position of the foramen magnum occipitis, evidently farther forwards in man than in animals, indicates that his voluminous head is to be kept in equilibrium by a

vertical line of support near the centre of its base. 2d. The ligamentum nuchæ, weak in man, is strong in quadrupeds. 3d. The curvatures of the spine are so varied as to diminish the tendency to fall forward when we are erect. 4th. The direction of the orbits of the eyes, which, looking forwards when we stand, and enabling the eye to apply itself to a vast circumference, would, in the quadruped position, be directed towards the ground, and thereby have the sphere of observation reduced to a few yards. 5th. The opening of the nostrils, when we stand, permits odors to ascend easily into the nose; in the other attitude, this opening would be directed backwards. Such are the circumstances, in connection with the head only, which indicate the necessity of the biped position for the full enjoyment of the functions which the Creator has given to us. But there are, also, others equally evident in the mechanism of the extremities, and of the parts of the trunk to which they are attached. Thus, 1st. The breadth of the pelvis, and the actual obliquity of its superior strait, in regard to the spine, prevent us from falling to one side, and at the same time, bring the lower extremities immediately in a line with the spine. 2d. The length of the neck of the os femoris, and the size of its condyles. 3d. The articulation of the knee, which permits the leg to be brought into a line with the os femoris, a position impracticable in quadrupeds. 4th. The foot being articulated at a right angle with the leg, and having its tarsus and metatarsus so well developed. 5th. The predominance of the transverse diameter of the thorax over the vertical, which, with the great length of the clavicle, and the shape of the scapula, unfit the latter for assisting much in progression. 6th. The shape of the hand, calculated to seize upon objects, but, from the length of its phalanges, not suited to sustain the body. 7th. The mode of articulation at the wrist, which, from its mobility and weakness in the direction to which the weight of the body would be applied to it, could not be brought to support it advantageously. And, lastly, the great disproportion of length, in the adult, between the upper and lower extremities, when an attempt is made to walk like the quadruped.

In considering the skeleton of the very young child, it is worthy of remark how closely its mechanism, with the exception of the head, corresponds with the habits of early life. A spine, nearly straight, and a pelvis, the lateral diameter of whose cavity is so small that the transverse base of support is much diminished, render erection inconvenient. Lower extremities shorter in proportion than the upper ones, having thigh bones nearly straight; also, the articulation of the knee not admitting of a full extension of the leg. All these circumstances prove that the quadruped position, inconvenient and intolerably irksome when continued for a length of time in the adult, is natural to the young infant.

The space between the ossa femorum, produced by the breadth of the pelvis and the length of their necks, and, therefore, always considerable above, varies below in different individuals. A certain distance at the latter point seems to be indispensable to convenient and graceful progression. Thus, when it is in excess, it produces the deformity called

bandy legs, and causes a tottering gait, such as may be mimicked, at any time, by walking with the legs in a state of abduction: but, when diminished, it is called knocked knees, and interferes with the firmness of the step, by causing the centre of gravity to pass, alternately, through the internal condyles of the ossa femorum, instead of falling exactly between them.

The firmest position in which we can stand is that in which the feet are perfectly straight and parallel with each other, so as to form a square base for the support of the trunk. If from this position the toes be turned either inwards or outwards, the consequent reduction of the antero-posterior diameter of the base causes less resistance to the natural inclination of the trunk forwards. Whatever may be the grace and the ultimate intention of the first position in dancing, to wit, that of having the feet nearly in the same line, with the heels touching and the toes outwards, it is certainly the most unfavorable attitude for ease in keeping the body erect that can be adopted; for the base of support being diminished, both by the length of the body of the os calcis, and by that of the foot, anterior to the ankle joint, the trunk is continually inclining either forwards or backwards, and is prevented from falling only by the alternate action of the muscles behind and in front.

When we are upon the knees, the base of support for the trunk being entirely withdrawn in front, it is necessary, in order to maintain the position and to prevent falling forwards, that the hip joint be flexed so as to throw the weight of the body entirely behind the thigh bones. The position is one of so much restraint and fatigue upon the muscles, that it can be maintained for a long time only by some artificial support in front, or by the buttocks falling down upon the legs, and resting against them.

The position we assume on being seated in a chair, is the easiest of any of those in which the trunk is kept erect or nearly so. The length of the lever, represented by the whole length of the skeleton, is then diminished one-half; consequently, any preponderance of it at particular points, above, bears with less force upon the base. The base itself is much augmented by the amplitude of the buttocks, and by the horizontal position of the thigh bones in front; and may be also increased, at pleasure, by the extension of the legs. If, under such circumstances, the trunk of the body be slightly advanced, its equilibrium is so easily maintained as to require but a very little muscular action to continue it. The most exposed part of the base is backwards; and, if the trunk be kept perfectly erect, there is some tendency of it to fall in that direction. Hence, the utility of backs to seats, and the fatigue from such as have not.

SECT. VI.—ON THE MECHANISM OF THE INFERIOR EXTREMITIES IN REGARD TO LOCOMOTION.

1. *Of the Motions of the Thigh.*

These, like the motions of the os humeri upon the scapula, consist in extension, flexion, abduction, adduction, rotation, and circumduction; but in consequence of being performed upon an immovable basis, the acetabulum, they are much less extensive. In order that they may be understood well, it will be useful to assume certain points of reference in the os innominatum and os femoris. These are the trochanter major, the pubes, and the anterior superior spinous process of the ilium. In standing, the lower external part of the trochanter major, where it forms a bulge on the side of the thigh bone, is on a horizontal line with the upper part of the symphysis pubis. A triangle, described by lines drawn from the anterior superior spinous process to the symphysis pubis —from the latter to the point mentioned of the trochanter, and from the latter to the anterior superior spinous process, will be nearly a rectangle, of which the base is above, and the shortest side behind.

The flexion of the os femoris is that motion in which its lower extremity is carried forwards. It is performed with great ease and freedom, in consequence of the arrangement of the articular surfaces of the bones and of the capsular ligament. The head revolves freely in the acetabulum, the ligamentum teres is put into a slight tension, and the end of the trochanter major approaches the sciatic notch. The extreme point of this motion is the one preserved by the os femoris of the fœtus in utero.

Extension is the reverse of flexion. When the latter has been performed, extension restores the thigh bone to its vertical position, and carries it some degrees farther, but cannot be executed to the same extent behind, that flexion is in front. When pushed to an extreme, it brings the trochanter major under the anterior inferior spinous process of the ilium, and the round ligament is put very much upon the stretch; it is finally arrested by the lower part of the neck of the os femoris lodging against the posterior elevated margin of the acetabulum, and by the thickened part of the capsule, in front and above, being so much distended as not to yield farther without laceration.

Abduction is the act by which the thigh bones are separated. When carried to an extreme, the under part of the head of the os femoris leaves the acetabulum, and distends very forcibly the capsular ligament at this point. The superior fasciculus of the round ligament is strongly extended; but the inferior fasciculus is kept easy, and, indeed, somewhat relaxed. This motion is arrested by the trochanter major striking against the ilium; without which it would be much more extensive, as the capsular ligament is strained at its weakest point, and relaxed at the strongest.

Adduction is the reverse of the last. The muscles which produce it, the adductors, from their situation and course, are unable to give an

extent to this motion much beyond the act of reinstating the thigh when it has been adducted. In this respect they are much less influential than the great pectoral muscle which adducts the os humeri. The articular surfaces of the bones are suited to a much greater latitude of this movement, but it is arrested both by a deficient power in the muscles, and by the strong upper part of the capsular ligament being put upon the stretch.

Circumduction is the regular succession in a circle of the four preceding motions, and is much less extensive in the os femoris than in the os humeri, for the reasons stated. The centre of the circle, or cone, thus described, is the head of the bone, and it is much more extensive anteriorly and externally, than posteriorly and internally.

Rotation, owing to the length of the neck of the os femoris, is extremely well marked, and is indicated by the trochanter major moving backwards and forwards. The radius of the circle thus described is the distance between the centre of the head of the os femoris and the bulging external part of the trochanter major. The rotation outwards or backwards is more fully and easily performed than the reverse, owing to the number and favorable position of the muscles causing it, many of which are specially appropriated to its production, and some others partially so. This movement is arrested by the neck of the bone striking against the acetabulum behind, and by the tension of the capsular ligament in front. Rotation, forwards, having but few muscles to produce it, and they neither specially devoted to it, nor acting very advantageously for the purpose, is arrested by the neck of the bone striking against the fore part of the acetabulum; by the tension, behind, of the capsular ligament, and also, by that of the ligamentum teres. When the convexity and the neck of the os femoris look directly forwards, it is indicated by the great toe pointing in the same direction.

2. *Of the Motions of the Leg.*

The movement of the leg upon the thigh is that of flexion, of extension, and a very partial degree of rotation.

In flexion, the head of the tibia slides backwards upon the condyles of the os femoris, which are prolonged behind, for the purpose of extending this motion. It is checked, when carried to an extreme, by the posterior margin of the tibia striking against the os femoris, and by the tension of the ligament of the patella. In the mean time, the lateral, the crucial, and the posterior ligaments are relaxed. The patella, always stationary, and at the same relative distance in regard to the head of the tibia, slides downwards upon the trochlea of the os femoris, and in the flexed position sinks between the condyles, so as to come in contact with the ligamentum mucosum.

In extension, the patella rises upon the condyles, and becomes prominent; the lateral ligaments are rendered somewhat tense, and the

motion is finally checked, by the resistance of the crucial and of the posterior ligaments of the articulation.

The rotation of the bones of the leg can only be performed when they are flexed, and the ligaments, generally, thereby relaxed, in which position a very limited motion, inwards and outwards, is perceptible. The motion outwards is the more extensive of the two, in consequence of the arrangement of the crucial ligaments, which are separated from each other by it. The motion, inwards, is limited by these ligaments being brought immediately by it into close and resisting contact with each other. In either case, however, the posterior and the lateral ligaments all contribute, ultimately, to arrest the motion.

In all these conditions of the leg, the semilunar cartilages slide somewhat upon the head of the tibia.

The articulation between the tibia and the fibula is such as to admit of no motion whatever below; but, above, a limited sliding backwards and forwards is performed by the fibula upon the tibia. This movement is made more perceptible in cases of extreme emaciation, and in general relaxation of the muscular system.

3. *Of the Motions of the Foot.*

The general motions of the foot upon the bones of the leg are flexion, extension, and an inconsiderable inclination inwards and outwards.

In flexion, the astragalus rolls backwards in the articular cavity formed by the tibia and the fibula, and is arrested by the anterior upper part of the astragalus coming in contact with the articular margin of the tibia. The ligamentous fibres and the synovial membrane, in front of the articulation, are relaxed; those behind are in a state of tension, as well as the tendo-Achillis, and the other tendons there. Luxation from an excess of this motion is almost impossible.

In extension, the foot is brought with the point downwards, so as to have its upper surface almost on a line with the bones of the leg. The astragalus glides forwards; the tendons, on the back of the joint, are very much relaxed. The joint itself is in a state the reverse of the preceding.

In the lateral motions, the sole of the foot is caused to present itself either obliquely inwards or outwards, whereby it may be accommodated to any inclined surface on which we walk. The first position is checked by the internal malleolus, and by the tension of the external lateral ligaments; the second, by the external malleolus, and by the tension of the internal lateral ligament. These motions constitute the adduction and the abduction of the foot, and by a regular succession with its flexion and extension, communicate a very limited and embarrassed species of circumduction.

The bones of the tarsus, for the most part, have a very obscure motion upon each other, with the exception of the articulation between the astragalus and the scaphoides, and between the os calcis and cuboides. At these points the movement upwards and downwards makes a sort of flexion and extension of the fore part of the foot, which is very distinct. A species of twisting, or oblique gliding, is also slightly perceptible there.

The bones of the metatarsus are susceptible of a slight elevation and depression, which, almost imperceptible at their bases, become sufficiently obvious at their anterior extremities. They also may be slightly approximated, at their fore parts, by the action of muscles, and by external compression. When the weight of the body is thrown upon them, they separate from each other, and the metatarsus loses, in some degree, the arched form of its anterior extremity below.

The phalanges of the toes have the same motions with those of the fingers, except that they are more restricted. The first of them, therefore, perform flexion, extension, adduction, abduction, and circumduction; the last two have only flexion and extension. The extension of the first phalanges is more extensive than their flexion, from whence results an important advantage in walking or in standing upon the toes. The shortness of the second and third phalanges of the small toes, together with the thickness of the sole of the foot contiguous to them in their extreme flexion, causes them rather to be doubled upon themselves than on the sole of the foot.

On the General Motions of the Lower Extremities.

These may be resolved into three; walking, running, and leaping.

In walking, though the first step may be taken in a variety of relative positions of the lower extremities to each other, yet it will make the investigation more clear to suppose the individual standing erect, with the two feet precisely on the same plane, and giving equal support to the trunk. The first step is then taken, by detaching the foot of one side from the ground; in order to do which, the thigh is bent upon the trunk, the leg upon the thigh, and the limb by being thus elevated becomes shorter. At this period the ankle joint remains at rest, with a slight inclination of the toes downwards. By the subsequent relaxation of the muscles of the limb advanced, with an inclination of the trunk to the same side, the limb is caused to descend upon the ground. These are the only motions when the step is short and easy; but, when a long stride is taken, by which the limb is put very much in advance of its fellow, in order to bring it to the ground, the pelvis is caused to rotate forwards on the head of the stationary thigh bone, whereby the trunk of the body, instead of presenting the sternum forwards, has it turned to one side.

When a step has been taken so as to leave one inferior extremity advanced before the other, for example the left, the limb behind is brought forward by the following mechanism. The left foot remaining fixed, becomes the point of support to the trunk; and the right, which

is behind, is elevated successively, from the heel to the toes, by the action of the muscles on the back of the leg, and rests upon the phalanges. The effect of this position is to elongate the right inferior extremity to the amount of the distance between the fore part of the ankle joint and the anterior extremity of the metatarsus, whereby that side of the pelvis is pushed forwards, and a rotation in advance impressed upon it. By the latter impulse, the foot of that side is wholly detached from the ground, the thigh being flexed at the same moment at the hip joint, and the leg flexed at the knee, the whole extremity is carried forward and fixed upon the ground, after the manner described in the first step. Ordinary progression results, then, from the regular succession of the last motion in the two extremities. In regard to the impulsion of the pelvis from the foot behind, this will probably take place in every case, more or less; it may, however, be reduced very much by a certain extent of flexion at the knee joint; and the want of it not be felt, because other powers concur to produce the same impulsion; as certain muscles, and also the momentum of swinging the lower extremity forward.

An equality of length in the lower extremities is indispensable to graceful and regular progression. If one of them be shortened from any cause whatever, it is manifested in the gait, by an unusual sinking of the pelvis on the defective side, at the moment the foot is brought to the ground, and from the continuity of the pelvis with the upper parts of the body, a considerable lateral inclination is communicated to the latter in the same instant. The pains frequently taken to conceal this defect disguise it very imperfectly, unless the shortness be only such as may be supplied by a shoe with a sole thicker than that of the other foot. Where the shortness arises from luxation upwards of the os femoris, a crutch is the best substitute for sustaining that side of the pelvis.

In running, the position of the feet is somewhat different from what it is in walking; they are extended so as to support the trunk on the phalanges alone, instead of on their soles: whereby a double advantage is obtained, that of keeping the lower extremities at their greatest possible length, and also of enabling them to detach themselves quickly from the ground. The velocity here is the principal difference between it and walking, yet there are some peculiarities.

The trunk of the body is kept continually and largely inclined forwards, which enjoins the necessity of a quick successive advance of the lower extremities to prevent it from falling. This position, also, by advancing the bony points, from which arise several of the muscles used in the extension of the thigh, removes these muscles more from the line of their contraction, and thereby enables them to act more advantageously and promptly. As each pace on these occasions is taken to the fullest stretch, the pelvis is rotated forwards from side to side, alternately upon the head of the os femoris, which may be fixed at the time. The face being directed forwards, whatever rotation in the vertebræ can occur, is then performed. As the pelvis communicates its motions to the trunk, so the latter carries its own to the upper extremities; which are thereby slung, alternately, backwards and forwards, and are brought, continually, to adjust the centre of gravity, which is then more in danger of being lost than in ordinary walking.

The ascent of an inclined plane, either by walking or running, is attended with unusual fatigue and difficulty, for the following reasons: In order to advance the thigh, it is necessary to give it great flexion at the hip-joint; the knee must also be bent in an equal degree, and the foot be flexed, in order to adjust it to the surface against which it reposes. To bring forward the other extremity, it requires an equal flexion at the hip and knee; besides which, its heel being below the phalanges, the foot must perform a full rotation at the ankle joint. The difficulty is somewhat diminished by stepping only on the phalanges. As, in these cases, the trunk of the body, to preserve its equilibrium, must be inclined forwards, there are certain acclivities, which, though they furnish a base sufficiently large for the foot, are yet impracticable from not allowing the trunk to be thrown forwards.

The descent of an inclined plane is more easy, because it requires but little flexion in the articulations mentioned to bring the extremity behind on a line with that in front; and its subsequent descent is produced by keeping it almost straight and shortening the extremity which is fixed. Running is then attended with some inconveniences, for the impulsion forwards which this motion communicates to the trunk, assisted by the inclination of the plane in that direction, determines a fall inevitably without a successively accelerated advance of the hind leg. We see frequently, in the descent of a very inclined hill, a step, at first guarded and leisurely taken, converted unavoidably into a full run to prevent the body from being precipitated forwards to the ground.

In jumping, the whole body is projected abruptly from the ground either in a vertical or oblique direction.

In the first, the lower extremities are shortened by a general flexure of their articulations; and by a very sudden and simultaneous extension of them, the resistance of the ground causes the whole frame to mount upwards till its gravitation causes the momentum to cease; it then descends, on the same principle with projectiles generally. In the oblique leap there is the same flexion in all the articulations of the lower extremities, with the addition of an inclination forwards of the trunk. At the moment when the limbs straighten themselves, the trunk is projected, not only upwards, but forwards, owing to its inclination, and describes in its ascent and descent a parabola. In this effort, the space traversed will be more considerable, if a previous horizontal momentum has been communicated to the trunk, by running several steps before the leap be made.

The more oblique the leap is, the greater will be its extent, to effect which the trunk must be inclined proportionably forwards. But to obtain this inclination without falling, it is necessary for one of the lower extremities to be very much advanced at the moment of springing with the other, so as to convert the motion into a very long step. With this position of the lower extremities, a much longer space can be cleared than if they were kept together.[1]

[1] For a further exposition of the principles of locomotion, see Joh. Alph. Borelli de Motu Animalium, 1710. Haller, Element. Physiol. tom. iv. 1757. Bichat, Anat. Descript. 1801. Barthez, Nouvelle Méchanique des Mouvemens de l'Homme et des Animaux, 1798. Encyclop. Anat. t. ii. Paris, 1843.

BOOK I.

PART III.

CARTILAGINOUS, FIBROUS, FIBRO-CARTILAGINOUS AND SYNOVIAL TISSUES.

CHAPTER I.

HISTOLOGY OF THE CARTILAGINOUS SYSTEM.

Cartilages (*Cartilagines*, *Système Cartilagineux*), besides being the nidus for bone in forming the skeleton, supply permanently the place of bone in many parts of the human body, as in the space between the ribs and the sternum, in the larynx, in the external ear, in the nose, and elsewhere. They are also to be found in all the movable, and in several of the immovable articulations. Wherever placed, they may be recognized by their whiteness, by their flexibility, by their great elasticity, and by a hardness only short of that of the bones. There are many animals whose skeletons are entirely cartilaginous, as the chondropterous or cartilaginous fishes, so excellent a substitute is cartilage for bone.

From the preceding distribution of the cartilaginous tissue, it is divided into articular cartilages, or those which cover the ends of bones in forming the joints; and into the cartilages of substitution, or those that supply the place of bone, so as to form a flexible *skeleton* or basis for the superimposed structure. The instances of the latter are, for the most part, fibro-cartilages or cartilage and ligament in union.

Cartilages have neither medullary canals nor areolæ in them like those of bones. The immersion of them in boiling water dissolves into a jelly, such as are found upon the articular surfaces of the bones, and a few others; but such as supply the place of bone, though softened by the process, are not rendered by any means so gelatinous.

Their chemical analysis, according to Mr. I. Davy, is gelatin 44.5; water 55; phosphate of lime 0.5. The testimony of different experimenters, upon the latter point, does not coincide, and their results must vary according to the kind of cartilage, and the period of life.

Cartilages are composed of a tissue exclusively their own, and of

parts which they have in common with other organs. The first has some very distinguishing properties. It resists putrefaction, either with or without maceration, longer than any other tissue, except the bones. In the midst of gangrene it preserves its appearance almost unchanged. Boiling gives it a yellow color, causes it to swell, and, if protracted, the gelatinous portion is dissolved. When dried, they become of a semi-transparent yellow, diminish in bulk, and lose their elasticity; in these respects resembling ligaments and tendons. From their bibulous structure they very readily swell out again upon immersion in water.

Cellular substance exists, in very small quantities, in cartilage, and is, therefore, not readily demonstrated; it is, however, made manifest by maceration, and by the action of boiling water: the latter, by dissolving the gelatinous portion, leaves a membranous and cellular substance. It is also stated that in certain diseases, the gelatinous portion being less abundantly secreted, the cellular is left in a soft spongy condition.

In a healthy state, no blood-vessels can be seen in articular cartilages; yet there are the strongest proofs of a species of circulation going on in them, either by very fine capillary vessels, or an interstitial absorption. All experienced anatomists have seen, in subjects affected with jaundice, the entire cartilaginous system losing its brilliant whiteness, and becoming of a light yellow. The cartilages, or rather fibro-cartilages, which supply the place of bone, and act in that way, as parts of the skeleton, exhibit a decided presence of blood-vessels in small quantity and not difficult to be detected in an advanced period of life by minute injection, or by a spontaneous congestion of blood in them; but in extreme old age, when ossification invades, to a variable extent, all of these structures, they, like the primary ossific cartilage, have a free evolution of blood-vessels, easily seen by the naked eye. This is especially the case in the cartilages of the ribs, whose ossification is very common, and generally found most abundant near the centre, but seldom so perfect as in the regular bones, there being a very large proportion of gelatin for the amount of calcareous matter.

Neither absorbents nor nerves have been traced into cartilages, and it is not possible to prove conclusively their existence by the circumstances of disease. We only know that in inflammations of the joints, terminating by anchylosis, the cartilages are removed; and that in some cases, even without evident inflammation, the cartilage disappears from a joint as if it had been worn away. Ulcerations of the arytenoid cartilages are spoken of as common by the French anatomists; and I have, since the first edition of this work, seen several instances in chronic Laryngitis; but it has not occurred to me to see any others unequivocally in this state.[1] It must, however, be borne in mind, that these approximate like the costal cartilages to the fibro-cartilaginous system. Possessed of no animal sensibility in the natural state, it is doubtful whether cartilages ever have it, or can inflame, as the pains in inflammations of the joints may arise from the synovial membranes.

In the embryo, the osseous and the cartilaginous systems are con-

[1] The late Dr. Physick's experience is also the same with my own.

founded, so as to present a homogeneous mucous or pulpy appearance; they only become distinct by the deposit of calcareous matter in the bones: when the latter are somewhat advanced, the cartilages, which are to remain such have also additional consistence, and more of a proper cartilaginous look; but the appearance is generally unsatisfactory, by which one can learn to distinguish the cartilages that are to remain such from the cartilaginous rudiments of the bones. The following circumstance, however, is pointed out by Bichat: in the cartilages of ossification, there is a vascular net-work between the cartilage and the ossification which has occurred, and owing to the interposition of it, the two may be easily separated. But in the permanent cartilage, this net-work does not exist between the proximate surfaces of the bone now formed and of the cartilage, consequently they adhere with a tenacity not admitting of an exact separation from one another.

The organic structure of every cartilage consists in a transparent amorphous substance, or matrix, with cells or vesicles numerously interspersed through it. These vesicles are ovoidal or of a notched lenticular shape, somewhat resembling a broad bean. In the mature cartilage the parietes of such cells cannot be well distinguished from the amorphous substance, which in this state is called the hyaline or vitreous cartilage. The cells themselves, now called Cartilage corpuscles, are filled with a softer substance, in which their nuclei repose apparently for the most part unattached to the walls of the cells, but not universally so. The nuclei have within them nucleoli.

In the mature state, cartilages present great diversity in their intimate texture, but while in a state of evolution they are much alike. Thus, the structure originates in cells as the rest of the body; but between the cells or vesicles is a larger proportion of hyaline or amorphous matter. The latter increases with the growth of the cells, and new cells spring out from cytoblasts or germinal particles existing in it. The early cells are much disposed to throw off shoots from their nuclei, and thus groups of cells are formed.

Permanent cell cartilages of the above description are seen in the septum narium, alæ and point of the nose, eyelids, external ear, Eustachian tube, larynx excepting epiglottis, and cornicula laryngis, trachea and its branches, the articular cartilages, costal, and ensiform of the sternum; but the cartilage corpuscles are far from being abundant in them.

In transient cell cartilage, that which is, for example, to be the nidus for bone, the vesicles or cells are very numerous in comparison with the matrix, and vary in size as well as in shape, some being round, others oval, and others compressed ovoidal. They, as stated in regard to the process of osteogeny, being first of all irregular in position, yet finally disposed into a sort of columnar or shafted arrangement, the ends of which point to the surface of ossification.

The cells of cartilages vary considerably, according to the cartilages themselves, in regard to both size, shape, and number. In the cartilages of the ribs they are from $\frac{1}{650}$th to $\frac{1}{430}$th of an inch in diameter, while in the articular cartilages they are from $\frac{1}{1300}$th to $\frac{1}{900}$th of an inch.

If the base of cartilage be pure and transparent, the cartilage is white or of a bluish white; if, on the other hand, the fibrous element prevail, then the cartilages have a yellowish tint. The cartilages which have a homogeneous base are called True—and those with a fibrous base are called False. There are, however, several of these bodies so much on the transition line that the distinction is observed with some difficulty, and there are changes depending upon the progress of life from early infancy to old age which also interfere with this classification.

Microscopic observers have remarked[1] that the closest resemblance exists between the structure of cartilages and of vegetables, so that an exact identity prevails in regard to the form, the grouping and even the mode of origin of their vesicles or cells. In all the mammalia, the state of ossific cartilage is uniform, this condition being varied only according to their degree of maturity for the reception of bony deposits. The permanent cartilages vary less in their appearance at different epochs, and their cells discovered by Purkinje are more closely packed as the cartilage is of more recent formation.

The peculiar character of cell cartilage is derived from the presence of a substance called Chondrin, which resembles much ordinary gelatin, but requires a longer process of boiling for its solution in water. Like gelatin it solidifies on cooling, and when the moisture is completely driven from it, it looks like hard glue. It differs from gelatin in not being precipitated by tannic acid; a difference is also observed in the case of several other re-agents. Thus, for example, it forms precipitates with acetic acid, alum, acetate of lead, and protosulphate of iron, which do not disturb gelatin, and it contains upon chemical analysis less nitrogen and more hydrogen.

The nutrition of cartilage, it is believed, is accomplished through the agency of the cells, or cartilage corpuscles. The cells contiguous to the blood-vessels of the region eliminate from the latter the requisite materials, and transmit them to the proximate series of cells; the latter do the same in their order, and so on in succession until the whole is nourished. In cases where from inflammation there has been a vascularity in articular and other cell cartilages, these vessels are formed in a new tissue, the product of the inflammatory process.

It has been ascertained that all the cartilages of a fœtus, both the ossific and the permanent, are composed of chondrin, but so soon as ossification commences, the chondrin of the former is changed into gelatin, while it remains constant in the permanent cartilages, unless they also change; this has led to the conjecture that, as chondrin is nearer alike to protein, so it is merely an intermediate stage for the formation of gelatin.

As the individual reaches adult age, the cartilages acquire the strength, whiteness, and great elasticity which distinguish them. In old age they become yellowish, more brittle, and are, as said, generally disposed to ossify. Those of the ribs and larynx are frequently ossified at forty years of age. The ossification of those of the movable joints

[1] Gerber, Gen. Anat. p. 171.

is rare, and begins at a more advanced period. In the first two it begins commonly near their centre, and in the last on the surface.

SECT. I.—PRETERNATURAL DEVELOPMENT OF CARTILAGES.

The abnormal development of cartilages, in the tissues and organs of the body, to which they are very slightly allied in their nature, is a circumstance by no means uncommon, and is met with annually, in most of its varieties, in our dissecting-rooms. As there is a great disposition in such cartilages to ossify, they are presented in the several gradations from a soft gelatinous body to that of perfect bone. They occur in the articulations; in the lungs, and form there fistulous passages; very frequently on the surface of the spleen; in the pleura; in the fibrous coat of the large arteries, particularly the arch of the aorta; and in the semilunar valves of the same; in the ovarium, when it becomes dropsical; and also in many other parts of the body.

The cartilages which are found loose in the joints and floating about there, begin, for the most part, in the fibrous structure[1] exterior to the synovial membrane; the latter is protruded inwards by them, and gives them a covering resembling the finger of a glove. As these bodies are small and rounded, when they protrude into the joint the synovial membrane forms a pedicle or base to them, which is finally ruptured, and then the cartilage becomes loose. These bodies are generally ossified in their centre; of course they have gone through the usual progress and phenomena of ossification. The other forms of preternatural cartilage are much disposed to ossify in the arteries, but not so much so in the other organs. In these cases they are laminated and adhere by their surfaces, very closely, to the contiguous structure, so as to be membranous. M. Laennec has seen a cartilaginous transformation of the mucous membrane of the urethra; M. Béclard of the mucous membrane in the vagina, attended with prolapsus uteri, and also of the prepuce of an old man, who had a phymosis from birth.

SECT. II.—OF THE PERICHONDRIUM.

All the cartilages, except the articular ones, are invested by a membrane called perichondrium (*perichondre*). It is best seen on the larynx, and on the cartilages of the ribs. Its structure is fibrous, and corresponds so fully with that of the periosteum, that it may be considered the same sort of membrane. It is, however, less vascular than the periosteum, and adheres to the cartilages with less force, owing to the fibrous connection between them being not so abundant. Bichat's experiments prove that the cartilage is much less affected by the loss of this membrane than the bone is by that of the periosteum: its uses are no doubt the same.

[1] Béclard, Anat. Gén.

CHAPTER II.

LIGAMENTOUS OR DESMOID TISSUE.

Histology of the Desmoid Tissue.

The Desmoid Tissue (*Textus Desmosus*, *Système Fibreux*) is very generally diffused in the human body, has a very close connection with the cellular texture, and is continuous with it in divers places. It may be known by its whiteness, the firmness and unyielding nature of its materials, and its fibrous arrangement. It is most commonly employed in fastening the bones to each other at their articulations, in enveloping the muscles, in connecting the latter by tendon to the skeleton, and in completing them; but it is also used in many other ways. Its application in the formation of the joints is our present object; but before that is particularly noted, it will be useful to enter into some general considerations in regard to its intimate structure, and the observations now made can be applied on all other occasions when this tissue is in question.

A desire to generalize, and consequently to simplify, has induced anatomists to seek for some fountain or source from which all the reflections and applications of the desmoid tissue might be traced. The Arabians thought that the dura mater was this source; and the error was sanctioned for a long time by the authority of Sylvius. The celebrated Bichat, in observing the connections of this tissue, finding that all its points of application might be traced either mediately or directly to the periosteum, considered the latter as its centre; as the heart is the centre of the circulation, and the brain of nervous energy; not that he thought the periosteum radiated its influence on all its dependent organs, but because anatomical inspection demonstrated all the fibrous organs to be connected with it, and communicating through it with each other. The late Professor Bonn, of Amsterdam, reversed the idea of Bichat, and considered the aponeuroses of the extremities, and of the trunk, which send their partitions between the muscles, and down to the periosteum and joints, as the much desired centre of the desmoid system. The latter idea has been reiterated by others, and the supposed emanations from the superficial aponeuroses diligently traced. As means of studying the position and connections of parts, notwithstanding the construction is a very forced one, which makes desmoid tissue cellular membrane, and cellular membrane desmoid tissue, alternately, so as to suit the arrangement of the anatomist, instead of that of nature; yet any or all of these plans have their use, and may be followed advantageously, after the study at large of the human fabric.

The desmoid tissue is essentially fibrous, but without a uniform arrangement, as its fibres are either parallel, crossed or mixed. There

are two species of desmoid tissue; the one most generally diffused is readily known by its whiteness and inextensibility. The other by its yellow tinge and by its elasticity, whence it is called the yellow elastic tissue.

The *White Desmoid or Fibrous Tissue.*—In some places the white fibres are very compact, and separate with difficulty, but generally prolonged maceration will cause them to part into filaments as fine as the thread of the silkworm. Anatomists differ in regard to the ultimate structure of these fibres. By M. Chaussier they are thought to be primitive and peculiar; Mascagni[1] supposed that they were lymphatics, enclosed in a vascular web; Isenflam, that they were cellular substance imbued with gluten and albumen; and M. Béclard, observing that maceration resolves them into a species of mucous or cellular substance, teaches that they are the latter in a condensed state, which opinion is corroborated by the microscope. Bichat's opinion was that the tissue is peculiar, and that maceration only brings into view the cellular substance which unites its fibres. Though maceration and chemical management evolve striking coincidences with cellular membrane, yet in the natural and ordinary state there are some very strong points of difference from it. Among these may be remarked its great want of elasticity, which causes it to tear sooner than to stretch, and in general anasarca, its being only very partially affected, merely rendered a little more moist and humid, which even then may arise from the small quantity of cellular substance in it. Many parts of it, however, are unaffected in the latter way, as the tendons and their sheaths. This tissue naturally contains a considerable quantity of water, which it loses by exposure to the air; it then is much reduced in volume, and becomes hard and yellowish, and is made semi-transparent by being put into spirits of turpentine.

The white fibrous tissue, according to the microscope, consists of ultimate transparent undulating filaments, having a diameter from the $\frac{1}{30000}$th to the $\frac{1}{10000}$th of an inch. The fasciculi into which they are collected measure from the $\frac{1}{7500}$th to the $\frac{1}{3750}$th of an inch broad, and have their ultimate filaments held together by an amorphous substance called the cytoblastema. The ultimate fibres appear to be identical in fibrous, fibro-cellular, and cellular tissue. The more obvious differences of these tissues arise from the mechanical apposition of the fibres, whether they are parallel or interwoven, or a combination of the two. If the fasciculi be absolutely straight, but a very small elasticity exists, amounting to almost nothing, as in the case of tendons; but in some of the developments of this tissue, the intertexture of their filaments and fasciculi imparts a high degree of elasticity. Like a muslin bandage, which if torn out straight yields but little, and if cut bias then is very elastic, a modification of property highly applicable in certain surgical dressings.

This tissue has, in many cases, its fasciculi observing a parallel wavy course in their fibres, which by the different reflections of light, produces a resemblance to a watered ribbon. This is the case especially in their larger fasciculi and in tendons.

[1] Prodomo della Grande Anatomia.

Fig. 70.

A microscopical view of the white Fibrous Tissue, magnified 320 diameters.—1, 2. The straight appearance of the tissue when stretched, as in ligaments of the funicular and fascicular kinds. 3, 4, 5. Show the various wavy appearances which the tissue exhibits when not stretched.

The white desmoid tissue, by being subjected to the heat of boiling water, contracts, becomes more solid, and is elastic; but if it be continued there, it gradually softens, becomes semi-transparent, and gelatinous. The mineral acids reduce it to a pulpy state, and, if concentrated, will dissolve it entirely. Acetic acid makes the filaments swell and be indistinct as in cellular tissue; it discloses nuclei and also the existence of the yellow elastic tissue in some amount. The alkalies loosen its texture, cause the fibres to separate easily, and to assume a diversity of colors. It putrefies but slowly, in this respect being next to the cartilages.

The strength of this texture is remarkable, and adapts it to the sustaining of enormous weights; a faculty which is continually in requisition, both to retain the articular surfaces of bones in contact, and the muscles and tendons in their places. It is well known that the patella, the olecranon, and the os calcis break frequently before their tendinous attachments will give way. In the history of punishments, where criminals have been fastened to four horses, it is said that it has been found necessary to use a knife to assist in their disarticulation. All these phenomena occur when abrupt violence is resorted to, so little are the ligaments disposed to yield; but when the causes of distension act slowly and gradually, as in dropsies of the joints, the fibres separate, and are sometimes completely disunited. When the distending cause ceases to operate in the latter case, the ligaments have the power of contracting in the same gradual way and of restoring themselves.

Some of the desmoid tissues, besides having their fibres surrounded and their interstices occupied by cellular substance, contain a very small quantity of oily or fatty matter. This is not very obvious in their recent state; but, by drying them, it will be seen in small quantities on their surface, like a greasy exudation; this probably comes from the fat vesicles deposited in their cellular substance. They are

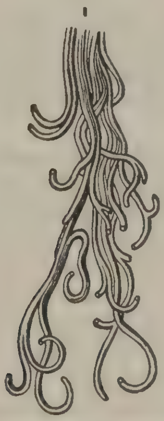
furnished but sparingly with blood-vessels, which, for the most part, are capillary. The periosteum and the dura mater are, however, exceptions to this rule. Lymphatic vessels have been observed in some of them, but it is doubtful whether they generally have nerves.[1]

S. Pappenheim has asserted that in his dissections he has been able to trace nervous filaments in the periosteum, in ordinary ligaments, in capsular ligaments; and sometimes in the tendons, but not those of the human subject; that they invariably attend the blood-vessels of these parts respectively and end in terminal loops.[2]

The sensibility of this tissue is extremely obscure, and is not manifested under the usual mechanical and chemical irritants; it may, however, be elicited by communicating to the joints a twisting motion, as the experiments of Bichat prove. Inflammation augments their sensibility, in which case it becomes extremely acute; as in gout and rheumatism, or any other cause productive of it.

The *Yellow or Elastic Desmoid Tissue* is far from being in the same abundance with the other. One of the best instances of it exists in the case of the ligaments between the bony bridges of the vertebræ; but it is found in the middle coat of the blood-vessels, in the skin, in the trachea, in the ligaments of the larynx, the stylo-hyoid, in the fasciæ, and in some other parts. A very remarkable example of it is seen in the ligamentum nuchæ of the larger quadrupeds, where it is introduced as an adjuvant to the muscles in keeping the head adjusted.

Fig. 71.



The yellow Fibrous Tissue, showing the curly and branched disposition of its fibrillæ, their definite outline and abrupt mode of fracture, magnified 320 diameters.—1. The structure undisturbed, and not moved from its natural position, as seen in the rest of the specimen.

Its chief characteristic is its elasticity, which it has to a very high degree; but in strength it is inferior to the white fibrous tissue, and it breaks across the course of its fibres. The fibres part without much difficulty from one another. As they run side by side, they observe a bending course, with curves wider than the white. They divide into

[1] Béclard, Anat. Gén.

[2] Müller's Arch. 1843.

branches at some points, and in others join with contiguous fibres so as to anastomose in a reticular connection. When the fibre is broken its end curls up. Their size varies from the $\frac{1}{24000}$th to the $\frac{1}{4000}$th of an inch. In the ligamenta subflava of the spine, their general diameter is about $\frac{1}{7500}$th of an inch. Their outline is remarkably distinct. Being to some extent generally blended with the white desmoid, or cellular tissue, they are rendered more manifest by touching them with acetic acid, which softens and partially dissolves the other without influencing them.

Their blood-vessels are but few in number, and it is not yet ascertained that they have lymphatics and nerves.

The elastic tissue does not contain quite so much water as the white. One-half is reduced by long boiling to gelatin; the other remains undissolved.

CHAPTER III.

HISTOLOGY OF THE FIBRO OR LIGAMENTO-CARTILAGINOUS SYSTEM.

THIS set of organs (*Système fibro-cartilagineux*) has been placed by anatomists indiscriminately in the cartilaginous or in the ligamentous system, in consequence of its participating in the characters of both; it, however, from its importance, should have a distinct position. There are three varieties of this system. The first presents itself in a membranous state, and is represented by the external ear, by the alæ of the nose, by the cartilages of the eyelids, and by the trachea. The second is represented by the inter-articular cartilages of the movable articulations, as of the knee, the wrist, lower jaw, and also by the inter-vertebral matter which holds the bodies of the vertebræ together. The third is represented by the trochleæ and sheaths, formed on the surface of bones for the sliding of tendons. These varieties differ much one from the other in the relative proportion of their constituents, and in the position of the same.

The principal constituent of this system is a strong fibrous matter, which is intermixed with the cartilage, and has in some places its surface covered by the latter. The fibres even by superficial observation may be traced in various directions: in some places they are parallel; in others intermixed and crossed very much; in others concentric. Their strength is of the first degree. The cartilaginous part fills up the intervals between the fibres, and gives to the whole structure its whiteness and elasticity.

The fibro-cartilages may be converted by the action of hot water into gelatin, but the process is slower than in the simple cartilage. The membranous, or first variety, differs, however, from the other two

in this respect; for, if it can be reduced at all into gelatin, the quantity it yields is not perceptible. The fibro-cartilages contain few or no cartilage corpuscles or cells, and, according to Müller, do not yield chondrin upon being boiled.

This system is destitute of perichondrium, with the exception of the first variety, in which it is distinguishable; but the others either adhere to the bone, or are covered by a synovial reflection; their margins holding in such cases to the contiguous ligamentous structure.

There is a very small quantity of cellular tissue in this system. Artificial injection manifests but few blood-vessels in it; if the animal, however, be strangled for the purpose, the blood by accumulating in the capillaries becomes sufficiently apparent.

CHAPTER IV.

SECT. I.—OF THE MECHANISM OF THE JOINTS.

The Ligaments (*Ligamenta*), properly speaking, are those organs which tie the bones together, and are mostly of the white fibrous tissue. In the movable joints they are either Capsular (*capsules fibreux*) or Funicular (*ligamens fibreux fasciculaires*). The first are like a bag open at the ends, at either of which the articular extremity of a bone is included. These are much more complete in some joints than in others; the shoulder and the hip joints afford the most perfect examples; in other joints they are divided into irregular fasciculi of fibres, permitting the synovial membrane to appear in their interstices, and sometimes they are still more widely separated.

The funicular ligaments are mere cords, extending from one bone to another; some of them are flattened, some rounded, and others oval or cylindroid. They are variously placed; in some instances they are surrounded by the capsular ligament, and in others, on its outer surface, and sometimes are so blended with it as not to be separated without an artificial disunion. Their names are derived either from their position or shape, and are generally sufficiently appropriate.

SECT. II.—OF THE ARTICULAR CARTILAGES.

To this class we refer, exclusively, such as adhere by one surface to the articular facings of the bones, and present the other surface to the cavity of the joint. Every movable, and some of the immovable articulations, have their surface uniformly thus incrusted to a thickness varying from the fraction of a line in the smallest joints, to one line in the largest. The cartilage itself is rather thinner near the margin of

the articular surface, when the latter is convex, than it is near the centre; on the contrary, when the surface is concave, the cartilage is thickest near its periphery.

These cartilages, when subjected to a maceration of six months, are stripped of the reflection of synovial membrane, which covers their articular surfaces, and are resolved into fibres, one end of which adheres to the bone and the other end points to the joint. If the preparation be then dried, the distinction of fibres becomes more manifest.

This filamentous appearance has been considered to depend upon the columnar arrangement of the cartilage cells, but, according to Dr. Leidy,[1] it is caused by the existence of intercellular filaments with a transverse measurement of only the $\frac{1}{25000}$th of an inch. The smoothness of the free surface of the articular cartilage, considered by some to be an extension of the synovial membrane, and by others to be the result of a transverse course of the cartilage cells, he concludes is produced by similar delicate filaments, forming a layer intermixed with cartilage corpuscles and parallel to the surface of the bone, a sort of capping, as it were, to the vertical filaments. He has also detected small lacunæ, near the attached surface of the articular cartilages and placed transversely, with filaments of bone laid in the same direction.

Fig. 72.

Represents a shred of Articular Cartilage, with a row of three cartilage-cells, torn from a broken edge of the articular cartilage of the condyles of the os femoris, highly magnified, exhibiting the filamentary structure.

The most successful injections, closely examined with a microscope, demonstrate the defect of blood-vessels in them. The vessels are uniformly seen to terminate at the circumference of the cartilage and at the face which adheres to the bone, but never to penetrate it. Their organization is, therefore, extremely simple, and such as subjects them to but few morbid alterations. When partially removed from the bone,

[1] Am. Journ. Med. Sciences, No. 2, Philad. 1849.

the latter occasionally reproduces them, but the edges of the new and of the old production do not unite. I have, in cases of inflammation of the joints, seen the fibres of these cartilages much longer than usual, and detached from each other. When a joint is laid open by a wound, and suppurates, the cartilage softens and disappears from the circumference to the centre.[1]

SECT. III.—OF THE SYNOVIAL ARTICULAR CAPSULES.

Each movable articulation is lined by a membrane (*membrana synovialis*), reflected over the internal face of the capsular ligament and apparently over the whole free surface of the articular cartilages. This membrane is a perfect sac; and, unlike the capsular ligament, has no opening in it. It is remarkably distinct where it is not attached to the articular cartilages, and, by being inflated, is caused to protrude in small vesicles, or pouches, between the fasciculi of the ligamentous structure. Its connection with the cartilage, and its continuation over it, are not quite so obvious, and require more management to demonstrate: it is, indeed, so thin and transparent at this part, and adheres so closely, that its existence there is questioned. The proofs to the naked eye are, that by maceration it becomes so loose, that, with a pair of forceps, shreds of it may be raised along the whole extent of the cartilage. If a flap of cartilage be raised up by a knife, its base being left attached, in attempting to tear away the base, it will be found that a membrane is continued from this base to the contiguous cartilage. Saw a bone through to its articular cartilage, then tear through the cartilage gently, in which case the continuity of membrane will also be manifested.

From these several proofs the fact was considered as established, that the synovial membranes are bags, closed at both extremities, and differ therein from the capsular ligaments. It would appear, however, that this apparent extension of the synovial membrane over the entire free surface of articular cartilage may be accounted for by the fine filamentous structure intermixed with cartilage cells, which makes the capping or surface to the articular cartilage, as described by Dr. Leidy. The actual influence of this arrangement, at least, is to furnish a modified membrane in connection with the regular synovial, but destitute of its vascularity.

In the fœtus, the synovial membrane may be traced over the whole surface of the cartilage.[2]

The synovial sacs are very vascular except upon the articular cartilages, where the vascularity is no longer apparent, or advances but a very short distance. M. Béclard says, that protracted inflammation will, finally, redden the cartilaginous portion, and that it extends from

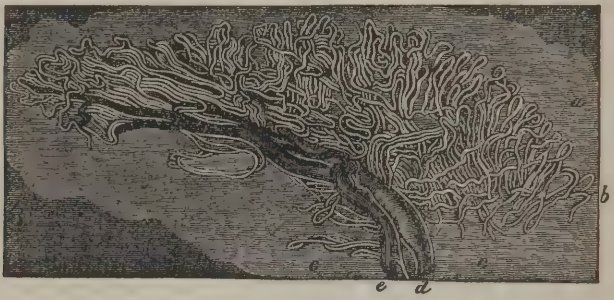
[1] Bichat, Anat. Gén. The same author speaks of the idiopathic ulceration of cartilage, as a result of its inflammation. The late Dr. Physick, whose experience was equal, denied both.

[2] Quain and Sharpey, vol. i. p. 245.

the circumference to the centre, the hues being lighter the nearer it is to the latter. It has not occurred to me to meet with this proof; though I have made frequent dissections of inflamed joints on subjects, the redness has always ceased at the margin of the articular cartilage. The late Professor Physick's experience, most valuable on all occasions, affords support to my own. Some years ago I had an opportunity of investigating, somewhat fully, this point, in a subject, all of whose large joints were in a state of inflammation.

The following magnified plate of the head of the os femoris, at from the third to the fourth month of fœtal life, will represent the very partial advance of vascularity between the synovial membrane and the articular cartilage.

Fig. 73.



a. The surface of the articular cartilage, near the ligamentum teres. *b*. The vessels between the said cartilage and the synovial membrane. *c*. The surface where the ligamentum teres was attached. *d*. The vein. *e*. The artery.

These synovial capsules, or membranes, are white, thin, semi-transparent, and soft. Wherever there is a deficiency of capsular ligament, they adhere to the contiguous cellular substance, and are so blended with it as to appear absolutely continuous. Dissection, inflation, and maceration, prove them to be laminated, and develop their structure in such a way that it resolves itself into a cellular tissue, the more interior layers of which had been in a very compact state. In all this they resemble the serous membranes, generally, and are ranked among them; Bichat, therefore, considers them only as an interlacement of absorbents, and of exhalants. But, for the farther exposition of this point, see the article on the Serous Membranes.

The synovial sacs have on their outer surface, but projecting into the cavity of the joint, adipose cushions of different sizes, called the Synovial Glands of Havers, from which it was long supposed that the lubricating liquor of the joints was exclusively secreted. These cushions have their projecting margins fringed and unusually vascular, and occupy the small spaces left between the articular faces of the bones. As they are covered by the synovial membrane and an epithelium, they no doubt assist in the secretion of the synovia. The original view of Havers has been reproduced lately by Mr. Rainey and Mr. Kolliker, with some additional details of structure in regard to the vessels and the fringed edges. The bursæ mucosæ found with tendons, and else-

where, as beneath the skin, and where surfaces of any kind rub upon one another, are similar to those of the joints.

The movable articulations are all furnished with the fluid called Synovia; this name was given to it by Paracelsus, from its resemblance to the albuminous part of an egg, to the consistence and color of which it has a close affinity, and, like it, is thick, ropy, and somewhat yellowish. The chemical analysis of it indicates the presence of water, albumen, and a kind of incoagulable mucus. It was once supposed to be a mixture of serum with the adipose matter of the bones, which found its way into the joints by transudation; but as it contains upon experiment no oil, the opinion is evidently erroneous. It is secreted from the whole internal surface of the synovial membrane, and, perhaps, in greater quantities from the fringed fatty cushions in the joints in consequence of their increased vascularity. M. Béclard teaches that it is neither a follicular nor a glandular secretion, nor a transudation, but a perspiration, in which a perfect equilibrium is kept up between its exhalation and its absorption. Its use is to diminish friction, and, consequently, to facilitate the sliding of the bones upon each other.

The synovial capsules are liable to a fungous degeneration, which occurs equally upon the cartilaginous and capsular portions of them. Factitious bridles sometimes form in the joints, attached indiscriminately to either portion of the synovial membrane.

CHAPTER V.

OF THE INDIVIDUAL ARTICULATIONS.

THE mechanism of all the movable articulations consists in a cartilage covering the articular surface of the bone; in ligamentous bands, either of a filamentous, funicular, or capsular condition; of a synovial membrane, and, as the case may be, of certain accessories, as inter-articular cartilages and so on. Where motion is not intended, various modifications of these elements of structure are observed. The several specifications will be given in the following account.

ARTICULATION OF THE LOWER JAW.

The articular connection here is formed by that portion of the glenoid cavity anterior to the fissure and by the condyle of the lower jaw. Each surface is covered by thin cartilage, and a thin, loose, irregular, fibrous, capsular ligament arises from the articular margin of one bone, to be inserted into that of the other. Besides this, there are four

other ligaments for strengthening the joint, an inter-articular cartilage and two synovial membranes.

The External Lateral Ligament (*Membrana Articularis Ligamentosa*) arises from the inferior margin of the root of the jugal or zygomatic process of the temporal bone, and from the anterior side of the meatus externus, and is inserted into the neck of the condyle. It is somewhat triangular, having the base upwards, and is identified with the capsular ligament. Just in advance of this, and separated from it by a small fissure, is another triangular ligament, the discovery of which is claimed by Caldani.[1] It arises from the anterior part of the inferior margin of the zygomatic process of the temporal bone, and is inserted into the neck of the bone in advance of the other.

Fig. 74.

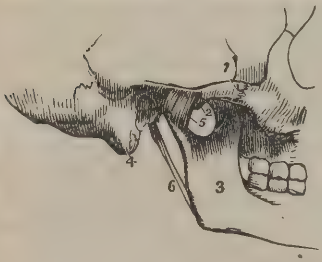


Fig. 75.

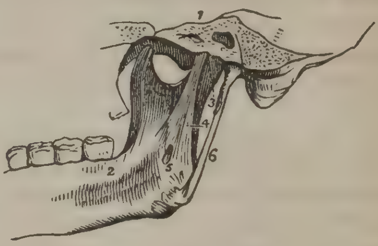


Fig. 74. An external view of the articulation of the Lower Jaw. 1. The zygomatic arch. 2. The tubercle of the zygoma. 3. The ramus of the lower jaw. 4. The mastoid process of the temporal bone. 5. The external lateral ligament. 6. The stylo-maxillary ligament.

Fig. 75. An internal view of the articulation of the Lower Jaw. 1. A section through the petrous portion of the temporal bone and spinous process of the sphenoid. 2. An internal view of the ramus, and part of the body of the lower jaw. 3. The internal portion of the capsular ligament. 4. The internal lateral ligament. 5. The small interval at its insertion, through which the mylo-hyoideus nerve passes. 6. The stylo-maxillary ligament, a process of the deep cervical fascia.

The Internal Lateral Ligament (*Lig. Maxillæ Laterale Intern.*) or Spino-maxillary, arises from the extremity of the spinous process of the sphenoid bone, and from the adjoining part of the petrous portion of the temporal bone, and going downwards and outwards is inserted into the spine bordering the posterior mental foramen, and for some distance lower down on the ramus of the jaw. It is placed between the two pterygoid muscles, and is in contact with the inferior maxillary vessels and nerve as they run between this ligament and the condyle to the posterior mental foramen. It is thought by Caldani to be not so useful in restricting the motion of the jaw forwards as in holding the vessels and nerves, and regulating their position, lest in the various motions of the lower jaw they should be displaced and injured.

The Stylo-maxillary Ligament is thinner than the above. It arises from the external side of the styloid process, and is inserted into the posterior margin of the jaw, near its angle, between the masseter and internal pterygoid muscles. The stylo-glossus muscle is much con-

[1] Tabul. Anat. Venetiis, 1802.

nected with it, and is thereby assisted in elevating the base of the tongue. The fascia profunda of the neck is in continuation with it.

Of the two synovial membranes, one is reflected between the glenoid cavity and the upper surface of the inter-articular cartilage; and the other between this latter body and the condyle of the lower jaw. They may be seen at different points protruding between the fibres of the capsular ligament.

The Inter-articular cartilage, by being placed between the two synovial membranes, separates completely the two bones. Above, its surface corresponds to the convexity of the tubercle of the temporal bone, and to the glenoid cavity; below, it is simply concave for receiving the condyle. It is thicker at the circumference than in its middle, and at the posterior than the anterior margin. A longitudinal section of it from before backwards and near its middle resembles the letter S. Sometimes it is open in the centre, in which case the two synovial cavities run into one another. Its structure is fibro-cartilaginous. It moves very readily backwards and forwards.

On the posterior face of the capsular ligament, I have found, in several cases (indeed, on all occasions of special examination for it, since the first observation), an erectile tissue or structure resembling the corpus cavernosum penis. It has not been filled with blood like the latter, but is, probably, an arrangement for giving great mobility forwards to the lower jaw.

The movements of this bone may be simply hinge-like, by its depression, in which the mouth is regularly opened; or, by the action of the pterygoid muscles, it may be slid forwards. When the muscles of but one side act, a species of rotation is communicated; in which one condyle advances on the tubercle of the temporal bone, while the other reaches to the back part of the glenoid cavity. The looseness and length of the capsular ligament of the articulation, along with the extreme facility of motion from the interposition of a movable cartilage, contribute very materially to this movement. The sliding backwards and forwards of the intermediate cartilage of this articulation, during mastication, sometimes produces a crackling audible to the bystanders, and extremely annoying to the individual who is the subject of it, from the noise being so near his ear.

Some persons are liable to a spontaneous dislocation of this bone, from yawning too widely. I am disposed to believe that, in such cases, the accident arises from the posterior boundary of the glenoid cavity (as established by that margin of the temporal bone which is continuous with the vaginal process, and forms a part of the meatus externus), being more advanced and higher than usual; in consequence of which, whenever the bone is depressed to a certain point, its neck strikes against this ridge, and not being able to go farther back, the ridge acts as a fulcrum, and starts the condyle over the tubercle of the temporal bone into the zygomatic fossa. The fact is certain, that very strongly marked differences of the glenoid cavity, in this particular, occur in different individuals.

CHAPTER VI.

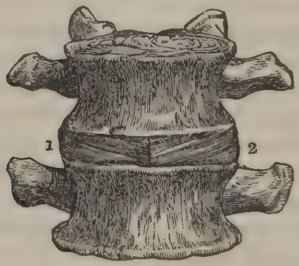
OF THE LIGAMENTS OF THE SPINE.

Ligaments of the Bodies of the Vertebræ.

1. *Inter-vertebral Substance* (*Ligamenta Intervertebralia*, *Ligamens Intervertebraux*).—The bodies of the true vertebræ are united by plates of a substance blending the nature of ligament and that of cartilage, and therefore called fibro or ligamento-cartilaginous matter. It occupies all the space between the contiguous bodies of the vertebræ, and adheres most closely to their substance. The plates of this inter-vertebral matter increase successively in thickness, as they are placed lower down on the spine, whereby the lumbar vertebræ are separated at a much greater distance than any others. The curvatures of the spine, as formerly stated, depend largely upon the arrangement of this substance: between the vertebræ of the neck the plates are thicker at the anterior margin than at the posterior; on the contrary, between the dorsal vertebræ they are thinner in front. In the loins, the plate is again much thicker in front than behind, and this feature is especially marked between the last lumbar vertebra and the sacrum.

This inter-vertebral matter is formed principally of concentric lamellæ, the texture of which is ligamentous. These lamellæ are more abundant anteriorly and laterally than behind. Their fibres cross in

Fig. 76.



Two Lumbar Vertebræ with the intervertebral substance are seen from before. By removing a portion of one layer of the latter, another layer is partly exposed, and the difference in the direction of their fibres is made manifest.

every direction, leaving between them intervals filled with a soft, pulpy substance, which is cartilaginous: the cartilage is defective near the circumference, but in approaching the centre, it becomes more and more abundant, as the interstices are larger, until the centre seems to be constituted almost entirely by it in a very soft state. The pulpy, or cartilaginous mass in the centre, is in a state of considerable compression, which may be proved by separating the bodies of adjoining

vertebræ, or by making a vertical section through them; in which case the pulp will be freed from compression, and will rise up into the form of a flat cone. This experiment will succeed remarkably well in the

Fig. 77.

Fig. 78.

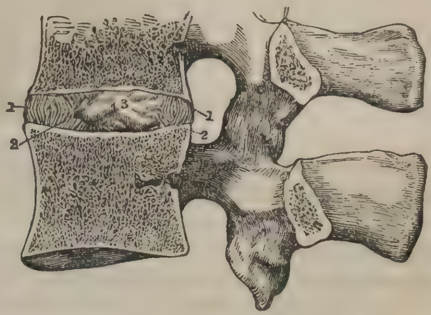


Fig. 77. A Lumbar Vertebra, with a horizontal section of intervertebral substance above it. At the circumference the concentric arrangement of the layers of the latter is shown, and in the middle the pulpy substance is indicated.

Fig. 78. A vertical section of two Vertebræ, and the substance interposed between their bodies. The direction of the layers of the intervertebral substance is displayed. 1. Layers curved outwards. 2. Those curved inwards. 3. Pulpy substance in the middle.

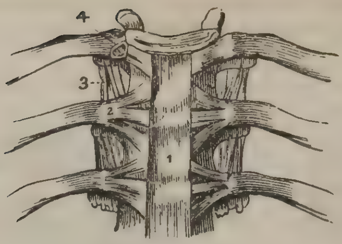
loins; from which it is evident that this mass is a soft and elastic ball, on which the bodies of the vertebræ play.

If the outer circumference of the inter-vertebral plate be cut through in the plane of its attachment to the vertebra, and the joint then forced open, it will be found that the strongest adhesion had been at the circumference, for the surfaces within part with comparative ease, and a thin scale or plate of cartilage will be found adhering to the face of the vertebra, and concealing it. This plate is, probably, the last vestige of the epiphysis of the vertebra.

The pulp is proportionably much more abundant in infancy than in the subsequent periods of life; it is also much softer, whiter, and more transparent. In advanced life there is great diminution of its volume, as well as of its elasticity, which accounts, in some measure, for the comparative stiffness of the spine in old people. The fibrous part in them is always more abundant, and is disposed to ossify. When the trunk is kept erect for several hours in succession, it becomes shorter, from its weight bearing upon the inter-vertebral matter; but a short period of rest in the horizontal position restores the spine to its original length.

2. *Anterior Vertebral Ligament* (*Fascia Longitudinalis Anterior*, *Ligament Vertebral Anterieur*).—This ligament is placed on the front part of the spine, and extends from the second vertebra of the neck to the first bone of the sacrum, inclusively. It increases gradually in breadth, from its commencement to its termination, but is not everywhere of the same thickness; for it is thin on the neck, thicker in the thorax, and again becomes thin in the loins: in the latter, however, it is strengthened by an accession of fibres from the tendinous crura of the diaphragm. It might be very properly considered as beginning at the cuneiform process of the occipital bone, as there is a fasciculus to

Fig. 79.



An anterior view of the ligaments of the Vertebræ and Ribs.—1. The anterior vertebral ligament. 2. The anterior costo-vertebral ligament. 3. The internal transverse ligament. 4. The inter-articular ligament, connecting the head of the rib to the inter-vertebral substance.

represent it, going down to the second cervical vertebra, but interrupted there, immediately after which it is resumed.

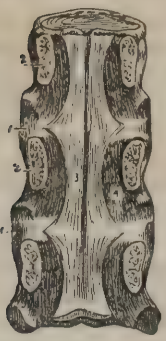
This ligament adheres very closely to the inter-vertebral substances, or plates, and to the projecting margins of the bodies of the vertebræ, but less closely to the middle or concave parts of the latter. Its fibres do not run out its whole length, for the more superficial extend from one vertebra or inter-vertebral substance to the fourth or fifth below; the middle ones extend to the second or third below, and the deepest seated are applied between the proximate vertebræ only. In general, more of the fibres are inserted into, and arise from the fibro-cartilaginous matter, than in the case of the bones. In several parts, but particularly in the neck, small slips are sent off obliquely to the vertebra below. The laminæ of this ligament leave intervals between them for the passage of blood-vessels.

Beneath the anterior vertebral ligament are found a great many short and insulated ligamentous fibres, extended obliquely from one vertebra to another which is contiguous. These fibres have different directions, and cross each other at acute angles; they adhere very closely to the fibro-cartilaginous matter, and leave interstices between themselves, through which the anterior vertebral ligament adheres to the same substance. Moreover, there are, at the sides of the bodies of the vertebræ, a number of short straight fibres, passing from the edge of the bone above to the edge of the bone below.

3. *Posterior Vertebral Ligament* (*Ligamentum Commune Posterius, Ligament Vertebral Posterieur*).—This is placed on the hind part of the bodies of the vertebræ, within the spinal canal, and extends from the cuneiform process of the occiput, just beyond the foramen magnum, to the os coccygis. It is more narrow and thick in the thoracic vertebræ than elsewhere. At each inter-vertebral substance it increases in breadth and adheres more closely, whereas, opposite the body of a vertebra it is narrower and more loose, by which arrangement a kind of serrated or unequal edge is formed on each side.

This ligament is more membranous and uniform in texture than the anterior, and presents a smooth, shining surface, resembling a tendinous expansion. Its fibres, also, do not run individually the whole length of the spine, but are in laminæ; the more superficial of which

Fig. 80.



A posterior view of the Spinal Canal, half of which has been cut away in order to show its interior.—1, 1. The inter-vertebral substance. 2, 2. Surfaces of the vertebræ from which the bony bridges have been removed. 3. The posterior vertebral ligament. 4. An opening for one of the vertebral veins.

have their fibres inserted into the fourth or fifth inter-vertebral substance or vertebra, below their origin. The middle laminæ are inserted into the second or third below, and the deeply seated into the first below. The blood-vessels do not penetrate the ligament, but pass by its sides into the vertebræ. The superior extremity of this ligament going from the second vertebra to the margin of the foramen magnum, is sometimes considered as distinct.

Ligaments of the Processes of the Vertebræ.

1. *Articulation of the Oblique Processes.*—These processes are faced with cartilage, and a synovial capsule is displayed upon them so as to shut up completely the cavity of the articulation. The capsular ligament is not uniform and fully developed, but is represented by a few irregular fibres, passing from one bone to the other.

2. *Articulation of the Spinous Processes.*—With the exception of the neck, ligamentous fibres (*ligamenta interspinalia*) are found to occupy the spaces between all the spinous processes, by passing their whole length from the spinous process above to the spinous process below. Muscles supply largely their places in the neck, and to some degree in the upper part of the thorax. These ligaments have much of a cellular structure above, but in their descent they become more compact, ligamentous and large, till, in the loins, they assume a very decided character, and have a quadrilateral shape.

At the extremities of the spinous processes, there is a ligamentous band (*lig. apicum*), belonging to the dorsal and lumbar vertebræ. Commencing at the seventh cervical, in connection with the Ligamentum Nuchæ, it terminates on the spinous processes of the sacrum. It is thin in the back, but on the loins it is very thick, and so blended with the tendinous origins of the muscles, that it is not very distinguishable from them. The fibres of which it consists are of unequal

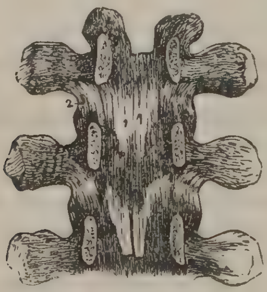
lengths, being extended between two, three, four or five vertebræ, accordingly as the fibres are superficial or deep-seated.

3. Owing to the shortness of the spinous processes of the neck, an arrangement exists there called Ligamentum Nuchæ (*ligament cervical*), or the Descending Ligament of Diemerbroeck. This ligament, though continuous with the one last described, may be considered, for the sake of perspicuity, as distinct. It begins, therefore, at the seventh cervical spinous process, ascends between the muscles of the opposite sides of the neck, and is inserted into the posterior occipital protuberance. It is blended very much with the tendons of muscles, and is distinguished from them with some difficulty, occasionally. Its posterior margin is thick, but the anterior is a thin membranous expansion, which runs to the ends of the spinous processes of the cervical vertebræ, and to the vertical ridge (*crista occipitalis*) of the occipital bone, leading from the occipital protuberance to the foramen magnum. The ligamentum nuchæ, therefore, forms a complete septum between the muscles of the opposite sides of the neck, and is continuous with the sheaths in which they play.

In quadrupeds it is remarkably strong, but in man, who from the proportions of his head and his erect position, keeps the head nearly in equilibrium, it is comparatively feeble. Much yellow elastic ligamentous material is found in its composition.

4. *Articulation of the Bony Bridges of the Vertebræ.*—The intervals between the vertebræ, at the posterior part of the spinal canal, are

Fig. 81.



An internal view of the Bony Bridges of the Vertebræ, after their separation from the bodies of the bones.—1, 1. One pair of the ligamenta flava, or yellow ligaments. 2. The capsular ligament of one side.

filled up by the Yellow Ligaments (*ligamenta flava or subflava*), so called from their peculiar color. These intervals exist between all the true vertebræ, being bounded laterally by their oblique processes, and are very considerable in the loins, particularly that below the last vertebra. They are not so large in the neck; are still smaller in the back; their shape varies considerably in the several portions of the spine.

The yellow ligaments are two in number, forming a pair, in each of these intervals: the two approach, behind, at an angle, in a line with the spinous processes, but are kept separated by a small vertical fissure

filled up with cellular substance. They extend to the oblique processes laterally; are connected to the anterior face of the bony bridge of the vertebra above; whereas, they are inserted into the superior margin of that of the vertebra below. From this arrangement, the yellow ligaments may be best seen on the inside of the spinal canal. The angle which they form behind is continuous with the ligaments between the spinous processes.

These yellow ligaments are smooth and shining on their anterior surfaces, but behind they are rough and unequal. Their fibres are numerous and extremely compact; their strength is, therefore, very great. Their elasticity is well marked and assists greatly in erecting the spine when it has been curved out of the proper line. Bichat says that there is but little cellular tissue between their fibres: that they are dissolved with extreme difficulty in boiling water, and resist its action to such a degree, that it is manifest they contain much less gelatin than the greater number of analogous organs. They are among the purest examples of the elastic ligamentous tissue.

The first pair of yellow ligaments is between the second and third cervical vertebræ, and the last between the last lumbar and the sacrum; there are, consequently, only twenty-three pairs in all.

Particular Articulations of the Spine.

1. *Articulation of the Occiput with the Atlas.*—The Anterior Ligament is placed at the anterior part of the occipital foramen, and extends

Fig. 82.

An anterior view of the Ligaments connecting the Atlas and Dentata with the Os Occipitis. The basilar process of the occipital bone and the petrous portion of the temporal being divided by the saw. 1. Central fasciculus. 2. The membrana annuli anterioris of Caldani. 3. The commencement of the anterior vertebral ligament. 4, 5. The capsular ligament of the oblique processes of the atlas and dentata. 6. The joint between the first and second cervical vertebra, after the removal of the capsular ligament. 7. The outer fibres of the membrana annuli anterioris.

from it to the corresponding edge of the atlas. On its centre in front is a fasciculus, which, being narrow and somewhat rounded, descends from the middle of the cuneiform process to terminate in the tubercle on the front of the atlas, and consists in parallel fibres; some of its fibres run into the anterior vertebral ligament. The remainder is called by Caldani, Membrana annuli anterioris atlantis (*ligament occipito-atloidien anterieur*). It occupies and shuts up the whole space, between the basilar process of the os occipitis, from which it takes its origin

Fig. 83.

A posterior view of the Articulation of the Occiput, Atlas and Dentata. 1. The atlas. 2. The dentata. 3. Membrana annuli posterioris. 4. The capsular ligament of the oblique processes of the atlas and the condyles of the occipital bone. 5. The ligament between the first and second vertebræ, representing a yellow ligament, but more loose in texture. 6. The lateral fasciculi of the same. 7. The first of the yellow ligaments. 8. The capsular ligament between the oblique processes of the second and third vertebræ.

near the occipital foramen, and the anterior arch of the atlas, into the superior margin of which it is inserted. In it are many oblique fibres, which run from within outwards.

The Posterior Ligament is placed at the back part of the occipital foramen, and extends from it to the corresponding edge of the atlas. It is called by Caldani, Membrana annuli posterioris atlantis (*ligament occipito-atloidien posterieur*), and arising from the whole posterior margin of the occipital foramen between the condyles, it is extended to the upper contiguous margin of the atlas, so as to fill up completely this space. Bichat says that it also consists in two laminæ, the anterior of which is fibrous, and runs into the dura mater of the spine instead of into the bone: the posterior is of a much looser texture, and resembles common cellular substance. A part of this membrane runs obliquely from the transverse process of the atlas to the part of the occiput just beneath the insertion of the rectus posticus minor. There is a good deal of the yellow elastic tissue in both the anterior and posterior membrana annuli.

The articulating surfaces of the condyles of the occipital bone, and of the superior oblique processes of the first vertebra, are covered with cartilage, and furnished with a synovial membrane arising from their margins. On the exterior of the synovial membrane there are irregular ligamentous fibres going between the bones, and forming a capsule.

2. *Articulation of the second Vertebra with the Occiput, and with the first.*—The second vertebra has no articular surface joining the occiput, but some strong ligaments are passed between them. When the posterior vertebral ligament is removed at its commencement from the occipital bone, we see on each side of it, and beneath it, ligamentous bands (*lacerti ligamentosi*), coming from the internal face of the os occipitis, to be affixed to the body of the second vertebra behind. Some of these fibres arise from the margin of the occipital foramen, and others from the internal face of the condyloid processes.[1] They are joined at their external margins by a few fibres from the first vertebra, near its upper oblique process.

[1] Caldani, Icon. Anat. Explicatio, vol. i. p. 255.

The Transverse Ligament (*ligamentum transversale atlantis, ligament transversal*) is placed immediately behind the processus dentatus, and divides the atlas into two unequal rings by being stretched from one side to the other. It is larger in the middle than at the

Fig. 84.

A posterior view of the Ligaments connecting the Atlas and the Dentata with the Occipital Bone. 1. The upper part of the posterior vertebral ligament. 2. The transverse ligament. 3, 4. The upper and lower appendices of the transverse ligament. 5. One of the moderator ligaments. 6, 7. Capsular ligaments belonging to the oblique processes of the first and second vertebræ.

extremities, and has the latter inserted into the little tubercle at the internal side of the atlas, between the upper and the lower articular surfaces. It is a thick, strong fasciculus of fibres, and binds the processus dentatus so as to form for it a sort of collar, amounting to about one-fourth of a circle. The superior appendix of this ligament arises by a broad base from the anterior margin of the foramen magnum, and terminates below by a narrow end in the upper margin of the transverse ligament. The inferior appendix arises from the lower edge of the transverse ligament, and is attached, by a somewhat converging end, into the posterior face of the body of the vertebra dentata.

The surfaces of contact belonging to the processus dentatus, and to the anterior ring of the atlas, are covered with cartilage, and have a synovial membrane, so as to form a perfect joint called the Vaginal ligament. A joint with a distinct synovial membrane is, in like manner, formed between the posterior face of the processus dentatus and the anterior of the transverse ligament, where they come into contact.

The Oblique or Moderator Ligaments (*lig. lateralia, ligamens odontoidiens*) are two, one on either side of the tooth-like process. They may be seen most advantageously by cutting through the transverse ligament, and arise from the side and summit of the processus dentatus, to be inserted into the internal margin of the occipital condyle. They are thick, short, and strong, and consist in parallel fibres; their lower margin has been considered as a distinct ligament by Weitbrecht, and described by him as coming from the neck of the process. There is some cellular tissue at the front, in which the process revolves.

The Middle Straight Ligament (*lig. medium rectum ligament droit moyen*), or Occipito-Dentate, arises from all that part of the summit of the processus dentatus anteriorly which is between the mode-

rator ligaments, and is inserted into all that part of the interior circumference of the foramen magnum between the insertion of the moderator ligaments. It is a thin ligamentous membrane, disposed to form in its middle a vertical fissure, separating its two halves. It cannot be seen well, unless the whole membrana annuli anterioris be dissected away, and the anterior bridge of the first vertebra sawed off; it will then be found immediately behind the bursa or vaginal ligament of the processus dentatus. It is separated from the superior appendix of the transverse ligament by a layer of condensed fatty substance. This ligament should not be confounded with the superior appendix of the transverse ligament, nor with the beginning of the posterior vertebral ligament, as has been done by Bichat and others. The difference is well established by Caldani, as it lies deeper than either of them when viewed from the vertebral cavity; though, from the close connection of the fibres of the ligaments among themselves, as well as with others, the mistake may readily occur.[1]

The Articulation between the oblique process of the first and of the second cervical vertebra is very movable, as the atlas is permitted to revolve around the processus dentatus to the amount of one-fourth of a circle at least. This articulation has a synovial capsule which is strengthened by an anterior and by a posterior ligament.

The anterior ligament of the articulation between these oblique processes arises from the inferior margin of the atlas and from its anterior tubercle, and is inserted into the base of the processus dentatus, and into the front of the body of the second vertebra. The fibres of the latter insertion are long and frequently distinct from the first.

The posterior ligament is placed between the first and second vertebræ, behind, and is connected to their contiguous margins so as to fill up the interval between them, and to supply the place of the yellow ligaments. It is extremely loose and thin, so as not to interfere in the movements of the vertebræ, and is of a fibro-cellular structure.

The synovial membrane of these oblique processes is unusually lax, and is reflected from the margin of the one articular surface to the other. It is in contact in front with the anterior ligament; behind with the posterior and with much cellular substance; internally with the ligaments within the spinal canal, and externally with the carotid artery. The latter obtains from it a serous covering, without which, according to Bichat, it would be bathed in the synovial fluid.

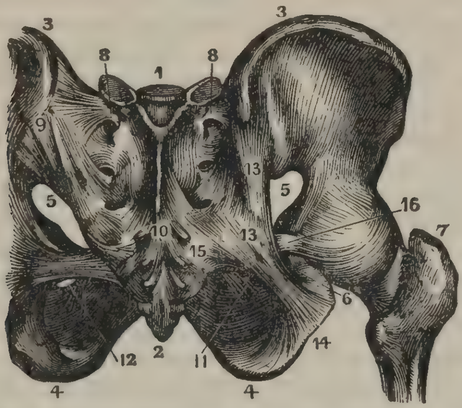
[1] Its existence is, however, scarcely to be considered uniform, as it is often wanting where the processus dentatus is very long, for example, when it reaches the anterior part of the foramen magnum and forms a joint there, as it sometimes does.

CHAPTER VII.

OF THE LIGAMENTS OF THE PELVIS.

THE mode of junction between the sacrum and the last lumbar vertebra is, in every respect, the same as that described for the bones of the spine generally, with the addition of a ligament on each side, sometimes met with, called Sacro-vertebral, which arises from the superior part of the sacrum by blending itself with the anterior fibres of the sacro-iliac junction, and, going obliquely upwards, is inserted into the transverse process of the last lumbar vertebra.

Fig. 85.



A posterior view of the Ligaments of the Pelvis. 1. Base of the sacrum. 2. The coccyx. 3, 3. The crista ilii. 4, 4. The tuber ischii. 5, 5. The greater sciatic notch. 6. The lesser sciatic notch. 7. The femur. 8. The posterior portion of the sacro-iliac ligament. 9. The sacro-spinous ligament. 10. The posterior sacro-coccygeal ligament in its whole length. 11. The obturator ligament. 12. The obturator foramen. 13, 13. The origin of the greater sacro-sciatic ligament. 14. Its insertion. 15. The origin of the lesser sacro-sciatic ligament. 16. Its insertion.

The Sacrum is united to the coccyx by a fibro-cartilaginous substance, resembling that between the bodies of the true vertebræ with the exception of there being less pulpy matter in its centre, and of its fibrous lamellæ being more uniform. The bones of the coccyx are also united with one another in the same way; in consequence of which they are very flexible till the approach of old age. A regular articular cavity is not unfrequently formed between the sacrum and coccyx.

The Anterior Coccygeal Ligament (*lig. sacro-coccygeum anterius*) is placed on the fore part of the coccyx; runs its whole length, and arises from the inferior extremity of the sacrum. Its fibres are rather indistinct, from their being blended with fat; on the lateral margins of the coccyx they are better marked.

The Posterior Coccygeal Ligament (*lig. sacro-coccygeum posterius*), as its name implies, is placed on the back part of the coccyx. It arises from the inferior margin of the spinal canal of the sacrum, and forms a sort of membranous expansion, which covers and adheres to the first bone of the coccyx, and is also inserted into the second. It may be viewed as an extension of the ligament at the end of the spinous processes of the Sacrum, and finishes off the sacral canal behind so as to close it. There are also a few other ligamentous fibres connecting the bones of the coccyx.

The Ilio-Lumbar Ligament (*lig. ilio-lumbare*) arises from the crista of the ilium for two inches near the lumbar vertebræ, and passing inwards is inserted into the transverse process of the last lumbar vertebra, and into its inferior oblique process. It is often blended with adipose matter, which separates it into several fasciculi. Caldani describes it as two ligaments, making a distinction between the one part fixed to the transverse, and the other to the oblique process.

The Sacro-Iliac Articulation is formed by the corresponding surfaces of the sacrum and ilium. Each bone is incrusted with its own cartilage, the one on the sacrum being somewhat more thick. Their surfaces are slightly rough, and between them exists a thick yellow fluid in a very small quantity, which lubricates them, and is more abundant in early life.

The Sacro-spinous Ligament (*lig. sacro-spinosum*) is placed superficially on this articulation behind. It is very strong, flat, long, and perpendicular. It consists of two laminæ, of which the more superficial arises from the fourth transverse process or piece of the sacrum, and is inserted into the posterior superior spinous process of the ilium. The deep-seated lamina arises from the third transverse process or piece of the sacrum, and is inserted into the same point. Bichat describes, connected with the inferior margin of this ligament, a fasciculus, which adheres to the posterior inferior spinous process of the ilium.

The Sacro-Iliac Ligament (*lig. sacro-iliacum*) is next to the articular faces of the bones. It surrounds the joint, but is much stronger on its posterior face. It consists in an assemblage of ligamentous fasciculi, some of which have obtained, by the writers on Syndesmology, particular names, but which it would scarcely add to the student's information to designate. On the front of the joint this ligament is uniform, and consists of a plane of short strong fibres, passing from the margin of one bone to that of the other. But, on the posterior surface, it is much more irregular, and arises from the first two pieces of the sacrum, by the eminences corresponding with the transverse processes of the true vertebræ, and from that surface of the sacrum between its articular face and these eminences. From thence the sacro-iliac ligament goes to be inserted into the rough surface of the ilium, immediately behind its articular face; it fills up there a considerable space, and, from its position, must be extremely irregular. Its strength is so great that in forcing the joint the ligament does not rupture, but

parts preferably from the surface of the ilium, and sometimes brings with it a lamella of bone.

The bones of the pelvis are also fastened by two other very strong ligaments, the sacro-sciatic.

The Posterior Sacro-Sciatic (*lig. sacro-ischiadicum majus*) is the most considerable of the two. It arises from the posterior inferior spinous process of the ilium, from the margin of the sacrum below this bone, and somewhat from its posterior surface, and from the first bone of the coccyx. It goes downwards and outwards, becomes thicker in its middle, but narrow; it then spreads out and is inserted along the internal margin of the tuberosity of the ischium. Its anterior extremity is extended along the internal face of the crus of the ischium for some distance, and has the obturator internus muscle adhering to it. Its fibres, where they converge from their origin, are separated into planes by bits of fat, and by blood-vessels.

The Anterior Sacro-Sciatic Ligament (*lig. sacro-ischiadicum minus*) is much smaller than the other, and is placed in front of it. It arises from the margin and somewhat from the posterior surface of the sacrum below the ilium, and from the lateral margin of all the bones of the coccyx. The fibres converge and are inserted into the spinous process of the ischium by embracing it. The fibres constituting its base have their fasciculi separated by cellular adipose matter and by vessels, and are also intermingled with the fibres of the coccygeus muscle, and of the posterior sacro-sciatic ligament.

The two sacro-sciatic ligaments supply, in some degree, the place of bone, and form a part of the inferior lateral parietes of the pelvis. They convert the sciatic notch into a foramen, or rather form with it two foramina; the upper and larger of which transmits the pyriformis muscle, the sciatic nerve and the gluteal blood-vessels, while the lower, placed between the insertion of the two ligaments, transmits the obturator internus muscle, and re-conducts the internal pudic artery into the pelvis.

The Obturator Ligament (*membrana obturatoria*) is extended across the foramen thyroideum, so as to close it up, with the exception of a foramen at its upper part, for transmitting the obturator vessels and nerves. It is a thin but strong membrane, having its fasciculi of fibres passing in various directions, and arising from the margin of the foramen. It affords origin to many of the fibres of the obturator muscles. Frequently portions of it are very defective.

The Articulation or Symphysis of the Pubes is formed between the bodies of the two ossa pubis. It consists principally in a fibro-cartilaginous matter, which has a strong resemblance to that of the vertebræ, but is destitute of its pulp. When the bones are torn apart by forcing them forwards, the fibrous arrangement becomes very apparent, and is seen to consist in concentric lamellæ, the fibres of which cross one another. Sometimes in the male, but most frequently in the female, the posterior third of the articulation is deprived of these fibres, in

place of which we find, in the middle of the cartilage, a small longitudinal cavity, the surface of which is smeared with a kind of mucosity. On the posterior surface there is often a ridge projecting into the cavity of the pelvis. From frequent observations made in our dissecting-rooms, I have no doubt that this articulation is always very much relaxed in the parturient and pregnant female, which is manifested not by the bones separating, but by their sliding upwards and downwards with great readiness. The sacro-iliac junction also becomes relaxed. It was upon the observation of these facts that the celebrated, but now exploded, Sigaultian operation was founded.

The Anterior Pubic Ligament is not very distinct. It lies in front of the last articulation, and consists in a few oblique and transverse fibres, going from the one bone to the other.

The Sub or Inter-Pubic Ligament (*lig. pubis inferius*) occupies the summit of the arch of the pelvis. It is of a triangular form, about half an inch in breadth, and passes from the margin of the crus of the pubes of the one side to a corresponding line on the other. It is remarkably strong, and is rather more so below than above. It is rather an extension of the ligament of the symphysis pubis than a distinct structure.

CHAPTER VIII.

ARTICULATIONS OF THE THORAX.

Posterior Articulations of the Ribs.

As mentioned, in the account of the bones, the articulations here are double; being formed at one point between the head of the ribs and the bodies of the vertebræ with the inter-vertebral plate; and at the other, between the tubercle of the ribs and the transverse process of the vertebræ. In either case the respective surfaces are covered by articular cartilage, and have a synovial membrane. The first joint is the Costo-vertebral, and the second the Costo-transverse.

1. The Costo-vertebral articulation presents an anterior ligament, an inter-articular ligament, and two synovial membranes. The Anterior or Radiating Ligament (*lig. capituli costarum*) is fixed, as its name expresses, in front of the joint. It arises from the margin of the head of the rib by the whole breadth of the latter, and diverging towards the spine, is fixed, by its superior fibres, into the vertebra above; by its inferior fibres, into the vertebra below; and, by its middle fibres, into the inter-vertebral plate. It is a thin, flat, fibrous membrane, leaving intervals in it for the passage of blood-vessels, and may, indeed, be considered as a capsule to the articulation, and is fre-

quently described as such. The inter-articular ligament passes from the ridge on the head of the rib to a corresponding line of the inter-vertebral substance. It is short and strong, and divides the articulation of the head of the rib into two cavities, which have no communication. It is in consequence of the latter, that there are two synovial membranes to the head of every rib which has a double articular face; but the ribs which are articulated with a single vertebra, as the first, the eleventh, and twelfth, have not the inter-articular ligament, and, therefore, only one synovial membrane.

The synovial membranes are not very apparent, neither is the fluid abundant; the cavity is occasionally very small from the encroachment of the inter-articular ligament. Anchylosis occasionally takes place here, but is more rare than in the anterior articulations of the thorax.

2. The Costo-transverse articulation has, in addition to the joint formed between the tubercle of the rib and the end of the transverse process, several ligamentous fasciculi which pass in varied directions.

The synovial membrane is much more distinct than in the preceding articulation, and contains more synovia. The joint is more loose, and is never anchylosed, except by disease. There are a few fibres around it having the semblance of a capsule.

a. The Internal Transverse Ligament (*ligamentum transversarium internum*, or *costo-transversarium inferius*) arises from the inferior margin of the transverse process, between its root and external extremity, and proceeding downwards and inwards, is inserted into the upper margin of the neck of the rib below. In many of the ribs there is a plane of ligamentous fibres parallel with this ligament, but just behind it, and arising from a more posterior situation of the transverse process to go to the neck of the rib, somewhat more towards the tubercle of the latter. It is designated by some writers as the posterior transverse ligament, but the distinction between it and the lig. trans. internum is so slight that it scarcely seems necessary to consider them apart. The Internal Transverse Ligament is much more conspicuous in the middle eight ribs, and in extremely emaciated subjects; in others, it is obscured by cellular adipose matter around the heads of the ribs.

b. The External Transverse Ligament (*ligamentum transversarium externum*, or *costo-transversarium posterius*) is a well-marked quadrangular plane of ligamentous fibres, placed on the posterior surface of the costo-transverse articulation. It arises from the extremity of the transverse process, and going outwardly, is inserted into the proximate rib, just beyond its articular tubercle.

c. The Middle Costo-Transverse Ligament (*ligamentum cervicum costarum*, or *costo-transversarium medium*) is extended between and concealed by the neck of the rib and the contiguous transverse process, and cannot be seen well without separating them, or by sawing through their length. It is a collection of short fibres, somewhat irregular, resembling condensed cellular substance, and slightly red.

These posterior articulations all require a patient dissection, as they are surrounded by small parcels of adipose matter, have the intercostal nerves and blood-vessels in contact with them before, and the muscles

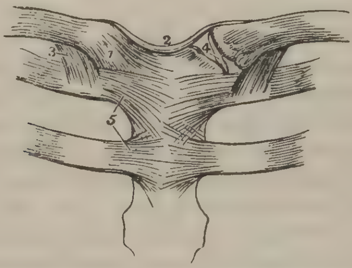
of the spine behind. The ligaments between the transverse processes and the ribs are, of course, not found in the eleventh and twelfth, from the bones not touching there.

Besides what has been described, an aponeurosis or ligamentous membrane is extended from the transverse process of the first and second lumbar vertebræ to the inferior margin of the last rib. A ligamentous membrane is also found near the spine, extended between the contiguous margins of the last two ribs.

Anterior Articulations of the Ribs.

The surface of each pit in the side of the sternum is covered by a

Fig. 86.



The Ligaments of the Sterno-clavicular and Costo-sternal Articulation.—1. The capsular ligament of the sterno-clavicular articulation. 2. The inter-clavicular ligament. 3. The costo-clavicular, or rhomboid ligament. 4. The inter-articular cartilage. 5. The anterior costo-sternal ligaments of the first and second ribs.

thin cartilaginous plate, to receive the corresponding cartilage of the rib, and the articulation presents an anterior and a posterior ligament, also a synovial capsule.

The anterior ligament arises from the extremity of the cartilage, and, going over the front of the sternum, radiates very considerably in every direction. Some of its fibres are continuous with the corresponding fibres of the opposite side; others are lost in the periosteum and in the tendinous origin of the great pectoral muscle; others join the fibres of the ligament above, and of that below. The more superficial the fibres are, the longer they become; but the more deeply seated pass only from the margin of the cartilage to the margin of the cavity in the sternum. The thick ligamentous covering found on the front of the sternum may be considered as only the continuation of these anterior ligaments. The fibres from the two lower articulations on the opposite sides form, by their junction, a striking triangular ligamentous plane, just on the lower end in front of the second bone of the sternum. Besides which, there are several strong ligamentous fasciculi running in a great variety of directions.

The posterior ligament has a similar arrangement with the anterior, in the radiation of its fibres into the contiguous ligaments, and in their origin from the costal cartilage. Altogether they form, on the posterior face of the sternum, a strong smooth covering, the fibres of which do not run in large fasciculi, but make a uniform polished membrane,

and are closely interwoven with each other. Some of these fibres are longitudinal, and, of course, cannot be referred to the posterior ligaments, but are independent of them.

The synovial membrane, though its existence is admitted, is not in a very distinct state. It scarcely gives a polish to the articular surfaces, and has so little looseness in its reflection from the one to the other, as to indicate clearly that but an inconsiderable motion is admitted in these joints. The synovia is in very small quantity, not abundant enough for satisfactory examination, and its character is rather inferred than proved. The first cartilage is continuous with the sternum, and not separated from it by any joint, except in rare instances. The second cartilage has its joint with the sternum, separated into two, one above and the other below, by a ligamentous partition resembling that at the heads of the ribs. The lower articulations become, successively, more movable than the upper.

Besides the attachments mentioned as connecting the cartilages of the true ribs to the sternum, there is one superadded to the seventh cartilage, called the Costo-Xiphoid Ligament. It arises from the inferior margin of the seventh cartilage, near the sternum, and going obliquely downwards and inwards, is inserted into the anterior face of the xiphoid cartilage, and has its upper fibres running into the corresponding fibres of its fellow. It is, of course, placed behind the rectus abdominis muscle, and fills up, in some measure, the angle between the seventh cartilage and the third piece of the sternum.

At the surfaces where the sixth and seventh costal cartilages come into contact by their edges, also the seventh and eighth, a synovial membrane exists. A similar articulation is sometimes found between the fifth and sixth, and the eighth and ninth cartilages, but not uniformly. These synovial membranes are covered by a strong fibrous capsule.

It has been already stated that the anterior extremity of the cartilage of each of the first three false ribs is united by ligamentous fibres to the cartilage above. These ligaments are strong and extensive, and give great solidity to the common margin of the cartilages. The last two cartilages being much smaller than the others, no ligaments pass from them; but they, with their ribs, are held in their position by the intercostal and the abdominal muscles.

The Costal cartilages adhere very closely to their respective ribs, which receive them into the oblong fossa at their anterior extremities. The periosteum of the rib is continuous with the perichondrium of the cartilage and the membrane, which is, in fact, one and the same, adheres very closely to the margins of the articulation; it is also reinforced by some ligamentous fibres beneath it. No motion whatever is admitted at this articulation.

CHAPTER IX.

OF THE ARTICULATIONS OF THE UPPER EXTREMITIES.

Of the Articulations of the Shoulder.

THESE articulations consist in the junction of the clavicle to the upper part of the sternum and to the cartilage of the first rib; of the scapula to the clavicle; and of the os humeri to the scapula.

Of the Sterno-Clavicular Articulation.

The uneven triangular face of the internal end of the clavicle, and the concavity of the sternum at its upper corner, form the surfaces which enter into this articulation. The first is much more extensive than the articular surface of the sternum, projects on every side beyond its margins, and is very prominent in case of extreme emaciation. The two surfaces are covered by cartilage, of which that on the clavicle is the thickest, and serves to fill up its inequalities; while the one on the sternum is thin and smooth.

The joint is invested by a thick fibrous capsule, the anterior portion of which presents a strong fasciculus of fibres somewhat separated by small interstices. This portion, the Anterior or the Radiated ligament, arises from the anterior extremity of the clavicle, and, going downwards and inwards, is inserted into the margin of the articular cavity of the sternum. It is placed just behind the origin of the sterno-cleido-mastoid muscle. The capsular ligament is also strengthened on its posterior surface by additional fibres, not so distinct as the preceding, but obtaining the name of the Posterior ligament.

The Inter-Clavicular Ligament (*lig. inter-claviculare*).—Closely connected with the capsule of the sterno-clavicular junctions, this ligament is placed on the superior end of the sternum, and extends from the internal end of one clavicle to that of the other. It is flat before and behind, thin and narrow, is blended with the contiguous ligamentous structure of the sternum, and might, with propriety, be considered only an appendage to the capsular ligaments, or a process sent between them. In front it corresponds with the integuments, and behind with the sterno-hyoid muscles.

The Inter-Articular Cartilage.—When the capsule of the joint is cut open, this is brought into view. It separates the bones completely from each other by its extent, and supplies by its shape the want of correspondence in their articular faces. It is thicker above than below; its centre is thin, and sometimes perforated. Its margins adhere closely to the capsular ligament; it is also fixed by adhesion to the upper posterior margin of the surface of the clavicle, and below to the union of

the sternum with the cartilage of the first rib; in consequence of which it has but little motion, and in luxations must be lacerated. Its structure is fibro-cartilaginous.

The Synovial Membranes.—There are two of these, one on each side of the inter-articular cartilage; in consequence of which a double cavity exists in this articulation, excepting the cases where the cartilage is perforated. These membranes contain but little synovia; they adhere closely to the adjoining surfaces, and cannot be made very distinct, except in points where there are small interstices in the capsule, when, by pressing the bones strongly together, they protrude in little vesicles.

Of the Costo-Clavicular Articulation.—It consists in a short fasciculus of ligamentous fibres, frequently called the Rhomboid Ligament, which, arising from the upper surface of the cartilage of the first rib, ascends obliquely outwards, and is implanted into the roughness on the inferior face of the clavicle, near its sternal end. Its fibres are parallel, all oblique, and longer at its external than at its internal margin. It corresponds in front with the origin of the subclavius muscle, and behind with the subclavian vein. It has for its object the strengthening of the junction of the clavicle with the sternum.

Of the Scapulo-Clavicular Articulations.

These exist at three places; the first by a junction between the acromion scapulæ and the external end of the clavicle; and the last two by ligaments sent from the coracoid process to the under surface of the clavicle.

The *Acromio-Clavicular Articulation* presents, on each bone, a small

Fig. 87.

The Ligaments of the Acromio-Clavicular and Scapulo-Humeral Articulations. Front view of left side.—1. The superior acromio-clavicular ligament. 2. The coraco-clavicular ligament. 3. The coraco-acromial ligament. 4. The coracoid ligament. 5. The capsular ligament of the shoulder-joint. 6. The ligamentum adscititium, or coraco-humeral ligament. 7. The tendon of the long head of the biceps muscle, issuing from the capsular ligament.

oblong face, covered with cartilage. The fibrous capsule which invests it is very strong and thick, so as to give the appearance of a much greater extent to the articular faces of the bones than really exists. This capsule is strengthened by additional fibres on its upper surface, passing from one bone to the other, and called the Superior ligament: they are parallel to each other, and partially blended with the tendinous fibres of the deltoid and trapezius muscles. The capsule is also strengthened on its lower face by additional fibres, constituting the Inferior ligament; they are by no means so abundant as the superior, and pass from the margin of one bone to that of the other, after the same manner. A synovial membrane is reflected over these articular surfaces, and contains but a very small quantity of fluid. In some instances, an inter-articular fibro-cartilage is found in this joint, as in the sterno-clavicular; in such case there is a double synovial membrane. And in most instances there is an approach to this arrangement by a ragged fibrous fringe projecting from the capsular ligament, in a circular ring between the bones.

Of the Coracò-Clavicular Ligament.—This ligament is double, one part being called the Conoid (*lig. conoides*), and the other the Trapezoid (*lig. trapezoides*). It arises from the roughness at the root of the coracoid process, and is attached to the under surface of the clavicle. The conoidal portion, having its base upwards, is inserted into the tubercle, near the external end of the clavicle. Its fibres are compact, strong, and diverging. The trapezoid is placed at the acromial side of the other. It is quadrilateral, longer, broader, and thinner than the other, having its fibres separated by small interstices. Arising also from the root of the coracoid process, it is inserted into an oblique line leading from the tubercle of the clavicle to its acromial end. The union of these two portions behind forms a projecting angle; in front there is a depression between them filled with fat and cellular substance, also a bursa mucosa. These ligaments are bounded in front by the subclavius, and behind by the trapezius muscles.

The Bifid Ligament (*ligamentum bicorne*) is placed in front of the subclavius muscle. It arises from the root of the coracoid process, at the sternal side of the conoid ligament: and proceeding with but little elevation, inwards and upwards, increases in breadth and bifurcates. The superior horn is inserted along the under margin of the clavicle to near the rhomboid or costo-clavicular ligament; but the lower one goes to the end of the first rib, under the tendon of the subclavius muscle. This ligament is a sort of fascia placed over the subclavius muscle to bind and strengthen it.[1] Some of the fibres of the superior horn occasionally proceed farther, and leaving the clavicle, go with the rhomboid ligament into the cartilage of the first rib.[2]

[1] This ligament is called the clavicular fascia by M.M. Velpeau and Blandin, in their treatises on surgical anatomy.
[2] Caldani, Plate xli.

Of the Scapular Ligaments.

The Coracoid Ligament (*lig. coracoideum*) stretches across the notch on the superior costa of the scapula, and converts it into a foramen. It runs from the posterior margin of the notch to the base of the coracoid process, and has some of its fibres blending with the conoid ligament. It consists of a small fasciculus of fibres, and is of very little consequence, excepting in its relation to the superior scapular vessels and nerves.

The Triangular Ligament (*lig. coraco-acromialis*) of the Scapula, as its name implies, extends from the coracoid to the acromion process above the shoulder joint. It arises from nearly the whole superior margin of the coracoid process, in two divisions, separated partially by cellular tissue. Its fibres converge in their progress, by which it becomes thicker, and is inserted into the point of the acromion process, just beneath its junction with the clavicle. This ligament is covered by the deltoid muscle and the clavicle, and has the supra-spinatus beneath it. Its anterior margin is continuous with a condensed cellular membrane beneath the deltoid.

Of the Scapulo-Humeral Articulation.

The glenoid cavity of the scapula, and the head of the os humeri form this joint. As usual, each articular surface is covered with cartilage, of which that on the os humeri is thicker in the middle than near its circumference, while the reverse occurs on the scapula. From the shallowness of the glenoid cavity and the much greater size of the head of the os humeri, but very few points of their opposed surfaces can come into contact at the same moment, though they may all do so in succession: hence a considerable portion of the head of the os humeri is always against the capsule of the joint. The remaining parts of this articulation are the capsular ligament, the synovial membrane, and the glenoid ligament.

The *Capsular ligament* (see Fig. 87) invests completely this joint, though it is thinner in some places than at others. It arises from the margin of the glenoid cavity, and is inserted into the neck of the os humeri, including a larger space of the neck below, than it does above. The tendons of the muscles which arise from the external and internal surface of the scapula, to be inserted into the tuberosities of the os humeri, as they approach their points of insertion, adhere very closely to the capsular ligament, and are, indeed, more or less blended with it. Bichat considers that the tendon of the subscapularis muscle supplies the place of the capsular ligament entirely at its lower part. This ligament is formed by fibres which are very much interwoven with one another, and have a greater degree of thickness above than below, or, indeed, at any other point. The former is due to a thick fasciculus, the Coraco-Humeral Ligament, also called by some, Ligamentum Ascititium, which takes its origin from the posterior and external margin of the coracoid process, and proceeding beneath the triangular ligament

to the upper part of the os humeri, joins the capsular ligament, and adheres very firmly to it. This ligament keeps the head of the os humeri on its proper level in regard to the glenoid cavity; but the moment it is cut, the length of the capsular ligament permits the head of the os humeri to fall about an inch, and, indeed, to suffer a partial dislocation. The strength of the joint, however, depends essentially upon the muscles which surround it, as the deltoid, supra-spinatus, infra-spinatus, teres minor, subscapularis, long head of the triceps, and some others, which are farther removed from it.

The *Synovial membrane* is a perfect sac, which covers the glenoid cavity, the internal face of the capsular ligament, and the neck and head of the os humeri. On the lower part of the neck it is reflected over some small fatty masses, commonly called glands. Just beneath the root of the coracoid process, from there being a deficiency of the capsular ligament, the synovial membrane covers the articular side of the tendon of the subscapularis, and is reflected for ten or twelve lines, between it and the scapula, forming a sort of pouch, resembling a bursa mucosa.

The Glenoid cavity itself is deepened by a fibrous margin all around, called the *Glenoid ligament*, a considerable part of whose fibres may be traced from the tendon of the biceps, by its bifurcating. The tendon of the biceps muscle runs through this articulation from the superior end of the glenoid cavity, and emerges at the lower end of the bicipital groove. The tendon is bound down in the bicipital groove by fibres passing from one to the other of the bony margins; they may be considered a continuation of the capsular ligament. As the tendon is about emerging from the groove at the lower margin of the tuberosities, the synovial membrane which lines the groove thus far is reflected from it to the surface of the tendon, and continues to cover and enclose it up to its origin at the glenoid cavity. It is thus evident that though the tendon passes through the joint, the cavity of the synovial membrane is kept entire.

Of the Elbow Joint.

This articulation is formed by the lower end of the os humeri and the upper end of the ulna and of the radius. The articular faces which were described in the account of these bones are covered, as usual, with cartilage, the particular arrangement of which will be presently pointed out. A strong capsular ligament, an annular or coronary ligament, and a synovial membrane, hold these several bones together.

The Capsular ligament invests completely the articular extremities of these bones, and conceals them from view. It is attached to the sides of the os humeri at the lower part of its condyles near the articular surface, but in front it arises some distance from the articular face at the upper margins of the sigmoid cavities, for the head of the radius and for the coronoid process of the ulna: behind, it arises in like manner from the upper margin of the cavity for receiving the

olecranon process; so that the depressions, both before and behind, are included within the circumference of the articulation. The lower part of the capsular ligament is inserted into the margin of the articular surface of the ulna, all around, including, also, the whole of the head of the radius, and the upper part of its neck.

This capsule is strengthened very much at particular points by funicular ligaments, as the coronary and lateral, and as the joint is hinge-like, the strengthening is more abundant at its sides, by the lateral ligaments.

The External Lateral, or the Brachio-Radial ligament (*lig. cubiti externum*) is connected above to the lower part of the external condyle, and is fixed below into the annular ligament which surrounds the neck of

Fig. 88.

Fig. 89.

Fig. 88. An external view of the Elbow Joint. Left arm from behind. 1. The humerus. 2. The ulna. 3. The radius. 4. The external lateral ligament. 5. The coronary ligament. 6. The insertion of the coronary ligament at the posterior part of the lesser sigmoid cavity of the ulna. 7, 8. The portions of the capsular ligament known as the accessory ligaments. 9. The interosseous ligament of the fore arm.

Fig. 89. An internal view of the Elbow Joint, left arm. 1. The capsular ligament. 2. The internal lateral ligament. 3. The coronary ligament. 4. The ligamentum teres. 5. The interosseous ligament. 6. The internal condyle, which conceals the capsular ligament behind.

the radius. It is very much connected with the tendinous mass common to the muscles at this part of the arm, more particularly that of the supinator radii brevis. It is a round fasciculus of parallel and condensed fibres spreading somewhat below into the annular or orbicular ligament. The Internal Lateral, or the Brachio-Ulnar Ligament (*lig. cubiti internum*) arises from the lower part of the internal condyle, and spreading out so as to assume a triangular shape, divides into two portions, one of which is inserted into the internal margin of the coronoid process of the ulna, and the other into the internal margin of the olecranon process. It also is much blended with the tendons of the muscles which lie over it. Intermediately to the lateral ligaments, the fibrous struc-

ture, both before and behind, of the capsular ligament is very distinct, but thin, in order to accommodate the motions of the joint; many of the fibres are insulated, and have interstices between them filled with fat. Some of these fibres are oblique, and others straight: they are called, in common, *Accessory ligaments*.

The Coronary Ligament of the Radius (*lig. radii orbiculare*) is brought more distinctly into view by cutting open the joint. It is then seen to arise from the anterior margin of the lesser sigmoid cavity of the ulna, and surrounding two-thirds of the neck of the radius, to be inserted into the posterior margin of the same cavity. It is a strong, flat, narrow fasciculus, the fibres of which go in a circular direction. Its superior margin is blended with the external lateral ligament: its inferior margin is loose, being connected with the lower part of the neck of the radius only by a reflection of the synovial membrane, with the exception that a few fibres pass from it behind, to the contiguous part of the ulna. Its density is very considerable, sometimes almost cartilaginous.

The Synovial Membrane lines the whole internal face of the capsular ligament, from which it is separated behind by a large pad of fat in the olecranon depression of the os humeri, and in front by another mass in the coronoid depression. A small circular ridge of fat also projects into the joint around the head of the radius, and there is another at the internal margin of the olecranon. The object of these masses seems to be to fill up the partial vacancies which exist between the articular faces of the bones, and they are all so directed by their attachment to the capsular ligament, as to be preserved from being pinched. The synovial membrane is also reflected from the capsular ligament to the articular faces of the bones, so as to line the sigmoid depressions on the os humeri, and to include the neck of the radius.

The head of the radius is completely invested with cartilage. The greater sigmoid cavity of the ulna has its articular cartilage separated transversely into two portions, by a small layer of fat traversing its bottom. The cartilage elsewhere is uniformly spread over the articular surfaces of the bones.

The Interosseal Ligament (*membrana interossea*).—It fills up the space between the two bones of the fore arm almost entirely by commencing just below the tubercle of the radius and ending near the wrist. It consists in oblique parallel fibres, which pass from the ulnar edge of the radius downwards to the radial edge of the ulna. It is thin but extremely strong, being covered in front by the flexor muscles; and behind by the extensors; and, as M. Boyer observes, seems to be intended rather to afford origin to muscles than to unite the bones. Its superior half is thinner above, and a large opening exists there for the passing of the interosseal vessels to the back of the fore arm. Its inferior part is thick, where openings also exist, but small, for the passing of the anterior interosseal vessels. There are some other smaller perforations in this ligament, but of less note than the pre-

ceding, also for vessels. On its posterior face there are one or two bands, the fibres of which decussate the other fibres.

Besides the interosseal ligament, there is one called *Round* (*lig. teres*), situated obliquely between the two bones at the upper part of the interval which separates them. It arises from the base of the coronoid process, just below the insertion of the brachialis internus, and descending obliquely outwards is inserted into the radius below its tubercle. Its object is to bind the bones together at a point which is weakened by the deficiency of the interosseal ligament. This deficiency is much larger than the simple passing of the vessels requires, for it also allows the tubercle of the radius to rotate freely backwards, a motion which would have been checked by the presence there of the interosseal ligament. The round ligament acts also as a check upon the undue supination of the hand. It is frequently defective or absent.

Of the Articulations of the Wrist.

Several articular cavities present themselves at this point. One is between the lower part of the ulna and of the radius; another between the carpal bones and those of the fore arm, and a third between the two rows of carpal bones. One general capsule invests these parts.

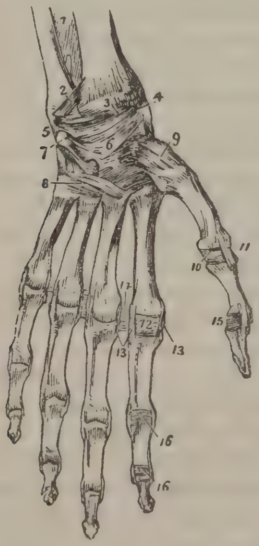
1. *The Lower Radio-Ulnar Articulation* is surrounded by a portion of the fibres belonging to the general capsular ligament of the wrist; their attachment, however, is so loose that they allow the bones to rotate freely upon each other, besides which they are not so abundant as in other places. When this joint is cut open it will be seen that the head of the ulna is covered with cartilage; also that the cartilage which covers the carpal articular face of the radius projects between the ulna and the os cuneiforme, and covers the sigmoid cavity of the radius; so that a cavity for receiving the convex head of the ulna is formed by the cartilage of the radius. The margins of the above projecting point of the radial cartilage are fibrous, which has induced the French anatomists to speak of it under the name of triangular ligament. It is, in fact, an inter-articular fibro-cartilage, and is said to be occasionally detached from the radius, but I have not seen it in that state; its centre is sometimes found perforated, so that a communication exists between this joint and the next of the wrist. Its margins adhere very closely to the capsular ligament, and its point is fixed into the depression which separates the styloid process of the ulna from its head. The synovial membrane which lines this cavity is unusually loose, both before and behind, in consequence of the great motion of the bones; it is also very loose above. This joint is called the Sacciform, from its looseness.

2. *Of the Radio-Carpal Articulation.*—The radius above, and the scaphoides, lunare, and cuneiforme below, form the basis of this articulation. An oblong semi-elliptical depression in the radius, the ulnar extremity of which is extended by the above cartilage of the radius, receives the convexity of the bones of the wrist. The scaphoides and the lunare come in contact with the radius, while the cuneiforme rests

against the projecting cartilage. There is a slight elevation of the radial cartilage opposite to the interstice between the first two bones. The articular cavity of the radius is filled by a corresponding head, on the part of the bones of the carpus, just enumerated. Each of the latter bones, in a fresh state, is covered by its appropriate cartilage. The cartilages are connected, or rather continued into one another, by a narrow fibro-cartilaginous substance placed at the margin of the interstice between the bones. This substance separates the cavity of the radio-carpal articulation from that of the proper carpal articulation.

The Capsular Ligament arises, before and behind, around the margin of the articular face of the bones of the fore arm, from the styloid process of the radius to that of the ulna, adhering very closely to the margins of the fibro-cartilage insinuated between the ulna and the cuneiforme. It is inserted below, into the circumference of the head formed by the scaphoides, lunare, and cuneiforme, though many of its fibres may be traced to the bones of the second row. It is a loose and thin membrane, the fibrous fasciculi of which leave interstices at several points between them, through which the synovial membrane may be seen. The capsular ligament is strengthened at particular places by additional fasciculi of fibres having appropriate names and being funicular

Fig. 90.



An anterior view of the Ligaments of the Wrist, on the left side. 1. The lower part of the interosseous ligament. 2. The radio-ulnar ligament. 3. The portion of the capsular ligament known as the anterior ligament. 4. The external lateral ligament. 5. The internal lateral ligament. 6. The capsular ligament of the carpal bones. 7. The pisiform bone. 8. The ligaments connecting the second row of the carpus with the metacarpus. 9. The capsular ligament of the carpo-metacarpal joint of the thumb. 10. The capsular ligament of the metacarpo-phalangial joint of the thumb. 11. The external lateral ligament of the same joint. 12. The capsular ligament of the metacarpo-phalangial articulation of the index finger. 13, 13. Lateral ligaments of similar articulations. 14. The inferior palmar ligaments. 15. The phalangial joint of the thumb, with its capsular and lateral ligaments. 16, 16. The same of the fore finger. The capsular ligaments have been removed in the other fingers.

in shape. For example, the *Internal lateral ligament* arises from the styloid process of the ulna, and is inserted into the cuneiforme, some of its fibres being extended to the anterior annular ligament, and to the pisiforme. The *External lateral ligament* arises from the styloid process of the radius, and is inserted into the radial end of the scaphoides, some of its fibres being continued on to the trapezium, and to the anterior annular ligament. The *anterior ligament* arises from the vicinity of the styloid process of the radius, and passing obliquely downwards and inwards, is inserted into the anterior face of the scaphoides, lunare, and cuneiforme. Its fasciculi are not very evident or well marked behind. The *posterior ligament* is not so broad as the last, and is more distinct. It also arises from the radius, by and near its styloid process, and descending obliquely inwards, is inserted into the lunare and cuneiforme. The last two ligaments have no connection with the ulna; the rotation of the fore arm is, therefore, unimpeded by them.[1] The fibres of this capsular ligament are best seen from the surface attached to the synovial membrane, and are identified with the funicular ligaments, excepting the internal.

The synovial membrane of the radio-carpal articulation is displayed over the articular faces of the bones and their intermediate fibro-cartilage, and lines the internal face of the capsular ligament. When the joint is pressed upon, this membrane is protruded, in the form of little vesicles, in the interstices between the fasciculi of the capsular ligament. A fold of it containing a small quantity of adipose matter is observed on the back of the cavity of the joint, passing from the junction of the scaphoides and lunare, to the corresponding point of the radius; it is the *ligamentum mucosum* of some writers.

3. *Of the Articulation between the two rows of the Carpal Bones.*—The scaphoides, lunare, and cuneiforme of the first row, and all the bones of the second row, are the foundation of this joint, the surfaces of which have been described already. These surfaces are covered with cartilage, each bone having its appropriate cartilage, which is continued on its side where the bone touches the adjacent one. The joint is furnished with a capsular ligament and a synovial membrane.

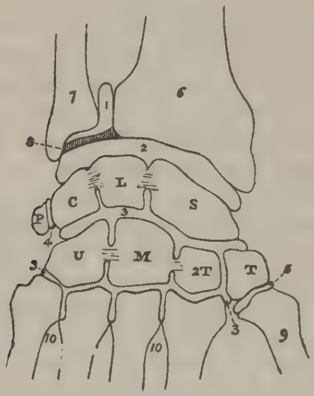
The Capsular Ligament surrounds the articulation, passing on every side from the upper to the lower row, and adhering strongly to the bones. It is in a great degree a continuation of the capsule of the radio-carpal joint, and has, at the same points, an increase of thickness by funicular ligaments, called after the same names. The internal lateral ligament is attached by one end of the cuneiforme, and by the other to the side of the unciforme. The external lateral ligament arises from the extremity of the scaphoides, and is inserted into the side of the trapezium. The posterior and anterior ligaments have the course of their fibres more distinctly seen on the side of the synovial membrane. The first consists in many fibres arising from the bones of the first row and going to the second row; its fibres are shorter and more compact.

[1] The ligamentous character of these several fasciculi is best seen on the surface next the cavity of the joint.

The anterior arises and is inserted after the same way, some of them terminating in the anterior ligaments of the hand.

The Synovial Membrane is not only extended over the opposed surfaces of the two carpal rows, but also is reflected upon the lateral faces of the bones belonging to each row. It therefore sends processes, two of which are found above; one between the scaphoides and the lunare, and the other between the lunare and cuneiforme. These processes are arrested at their upper extremities by the fibro-cartilaginous matter

Fig. 91.



A diagram showing the arrangement of the five Synovial Membranes of the Wrist Joint. 1. The sacciform membrane. 2. The joint between the first row of carpal bones and those of the fore arm. 3, 3. The synovial membrane between the two rows of bones. 4. The joint between the pisiform and cuneiform bone. 5. The synovial membrane at the metacarpal joint of the thumb. 6. The radius. 7. The ulna. 8. The inter-articular cartilage, or triangular ligament. 9. The metacarpal bone of the thumb. 10, 10. Those of the fingers. The capital letters indicate the separate bones of the carpus: thus, S. Scaphoides—L. Lunare, &c. &c.

between the bones, which was spoken of in the radio-carpal articulation. It also sends three processes downwards, one between the trapezium and the trapezoides, another between the latter and the magnum, and the third between the magnum and the unciforme. Of those latter processes, two or three communicate with, or are continuous with the synovial membrane, between the carpal and the metacarpal bones of the fingers.[1] The connections and reflections of this membrane are of the greatest importance, as they form a communication from the top of the wrist to the base of the metacarpal bones; not only covering the articular surfaces, but being prolonged in some instances beyond them, as on the back of the os magnum, where it answers as a periosteum.

In addition to the articulation just described, between the two rows of carpal bones, the individual bones of each row have particular fastenings of funicular ligamentous fibres, which run transversely from the margin of one bone to the margin of the next. These fibres, from their position, are called dorsal and palmar ligaments. The upper row has one dorsal ligament between the scaphoid and lunar, and another between the latter and the cuneiforme; it has in the same way

[1] Bichat, Anat. Descr.

two palmar ligaments on its front surface. The lower row has, after the same plan, three dorsal and three palmar ligaments between its bones. These several ligaments are best seen on the side of the synovial membrane, as externally their fibres are very much mixed with those of the capsular ligament. It is obvious that they are highly useful in preventing the bones from sliding laterally on each other, except to a small extent.

The Pisiform Bone has an articulation with the cuneiforme completely distinct from any other. The articular faces of this joint are covered with cartilage and invested by a synovial membrane and a capsular ligament, which allow, from their looseness, considerable motion. The capsule, though generally thin, is strengthened by funicular accessory fibres, which are well marked below. These fibres arising from the inferior extremity of the pisiform, some of them are attached to the extremity of the unciform process of the os unciforme, and others to the base of the fifth metacarpal bone. The insertion of the tendon of the flexor carpi ulnaris answers as a ligament to this bone above, and as there is a very strong fasciculus of ligament, passing from the pisiforme to the end of the unciform process, by that means the action of the flexor ulnaris is conveyed to it, and the pisiform thereby is prevented from being pulled out of its place. The pisiform bone acts, indeed, as a sesamoid bone or patella in the course of the insertion of the tendon of the flexor ulnaris. The pisiform has but little motion from above downwards, and a good deal laterally.

Of the Carpo-Metacarpal Articulations.

The bony articular surfaces, here, as well as all the others of the hand, have been sufficiently described and are in the recent state covered with cartilage. It will, therefore, be unnecessary to renew the observations on these subjects.

The first of these articulations, or that of the metacarpal bone of the thumb, with the trapezium, is much more movable than any of the others, and presents some peculiarities. It is entirely distinct from the others, slightly removed from the next, and is surrounded by a capsule which is attached by its ends to the articular margins of the bones. This capsule is strengthened by additional or ascititious fibres, which are particularly strong and abundant, posteriorly and externally. The synovial membrane is displayed, as usual, on the internal face of the capsule, and over the articular faces.

The other four metacarpal bones are articulated as follows: The second one is joined to the trapezoides, trapezium, and magnum; the third unites to the magnum alone; the fourth to the unciform, with a small portion of the magnum, and the fifth to the unciform. The ligaments are placed before and behind, and may also be termed dorsal and palmar.

The *dorsal ligaments* descend from the carpal to the metacarpal bones. The second metacarpal bone receives two ligaments, one from the trapezium, and another from the trapezoides; the third receives one from the magnum; the fourth receives two, one from the magnum,

and the other from the unciform; the fifth receives one from the unciform. Transverse funicular fibres pass between these dorsal ligaments to connect the bases of the metacarpal bones.

The *palmar ligaments* are arranged on a plan corresponding with that of the dorsal; but, from the length of their superficial fibres, are not so distinct from each other. Transverse fibres pass also between the metacarpal bones of the fingers at their base, and form interosseous ligaments which keep them together. A very strong ligament of this kind goes from the metacarpal bone of the fore finger to that of the thumb.

The articulations thus formed and held together, are covered by two synovial membranes, being processes from that between the two rows of carpal bones. One of these processes, sent down between the trapezoides and the magnum, displays itself over the inferior surface of these bones and the head of the metacarpal bone of the fore and of the middle finger. The second process, which is sent down between the magnum and the unciform, is reflected over the last two carpo-metacarpal articulations. These processes have a septum between them, at the ulnar side of the base of the third metacarpal bone, and do not communicate with each other, except through the proper carpal articulation. The specification of this arrangement is overlooked by anatomists generally.

The Inferior Palmar Ligaments are three in number, and are between the lower ends of the metacarpal bones of the fingers: each one consists in a transverse fasciculus, placed between the flexor tendons and the interosseous muscles, and on a level with the anterior part of the first joint of the fingers. Their more superficial fibres may be traced across the bones, and are somewhat blended with the capsular ligaments; the more deep-seated are short, and pass from one bone to the other.

Of the Metacarpo-Phalangial Articulations.

These are formed by the lower ends of the metacarpal bones, and the upper ends of the first phalanges. The funicular instead of the capsular ligament prevails. Each one presents an anterior ligament, two lateral ones, and a synovial membrane.

The Anterior Ligament[1] is a flat fibrous semicircle, on the front of the articulation, and of considerable thickness. It goes transversely, and has its two extremities attached to the ridge on either side of the articular margin of the metacarpal bone. Its inferior margin descends a little, and comes in contact with the synovial membrane. In front, many of its fibres are obtained from the fibro-cartilaginous sheath of the flexor tendons, so that it may be considered as made by two planes —the palmar one facing towards the tendons, and forming the trochlea, in which they play, and the other being next to the joint, and continued to the lateral ligaments. The thickness of the anterior ligament, besides communicating great strength to the joint, is useful in

[1] Bichat, loc. cit.

removing the tendons from the axis of the phalanges, and thereby giving increased power and delicacy of motion to the muscles. Bichat considers himself to have first indicated particularly this structure, which he thought was intended to protect the articulation from the impression of the tendon: to which may be added, in the firm grasping of bodies, and to make the movements of the joint more delicate. On the sides of this ligament belonging to the thumb, and in its thickness, are developed the sesamoid bones.

The lateral ligaments are situated one on each side. They arise at the pits or the sides of the metacarpal bone behind the former, and in connection with it, and, descending obliquely forwards, are fixed into the sides of the base of the first phalanx. They are round, distinct, and strong, and are formed from numerous parallel fibres.

The Synovial Membrane lines this articulation, being displayed over its lateral and anterior ligaments, and on the articular faces of the bones. It is reflected on the metacarpal bone, some little distance above the margin of its cartilage in front, whereby the cavity is enlarged, and the flexion of the fingers is favored. It is in contact, behind, with the tendon of the extensor muscle, which there supplies the place of capsular ligament.

Of the Phalangial Articulations.

There are two of these to each finger, and one only to the thumb. They are provided with an anterior ligament, a lateral ligament on each side, and a synovial membrane.

The anterior Ligament corresponds so exactly with what has been said in the preceding article on the same structure, that, with the exception of its being smaller, the description already given will suffice. It seems to answer in every respect the same objects.

The Lateral Ligaments, also, arising from the sides of the phalanx above, run downwards and somewhat forwards to be inserted into the upper part of the sides and the base of the phalanx below.

The Synovial Membrane has reflections corresponding with those of the preceding articulations, with the addition that it covers more of the anterior inferior face of the first and second phalanges. Thus, by cutting through the anterior ligament, longitudinally, and turning it aside, it will be seen that the cavity of the second and third joints of the finger is, by this reflection of the synovial membrane, extended upwards between the phalanx and the flexor tendons, nearly one-third of the whole length of the phalanx,[1] a circumstance worth attending to in the accidents of the part. The synovial membrane from the deficiency of capsular ligament behind is also in contact there with the extensor tendon, as the latter supplies the place of ligament. Hence all the joints of the fingers are very near the surface upon their posterior semi-circumference and easily laid open by accident.

[1] Bichat, loc. cit.

CHAPTER X.

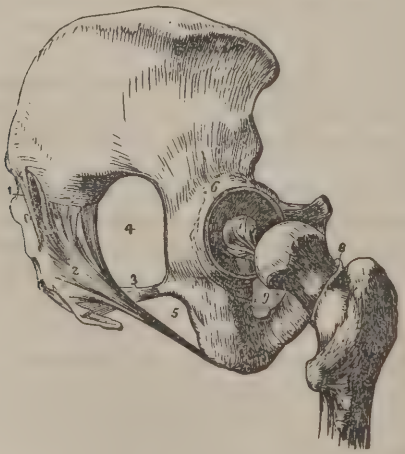
OF THE ARTICULATIONS OF THE LOWER EXTREMITIES.

Of the Ilio-Femoral, or Hip Articulation.

THE basis of this articulation is laid by the head of the os femoris being received into the acetabulum. Both surfaces are covered by thick cartilage: in the former it is interrupted, however, by the depression near the centre, and becomes very thin near the margin; and in the latter, the cartilage is deficient in the whole extent of the rough surface at its lower part. A cotyloid ligament, a fibrous capsule, the round or inter-articular ligament, and a synovial membrane, are, moreover, concerned in this joint.

The Cotyloid Ligament (*lig. cotyloideum*) is a fibrous prismatic ring which tips the margin of the acetabulum, and thereby increases its depth; it can only be seen by cutting open the capsule. Its thickness is unequal, being considerable on the anterior third of the circumference of the acetabulum, where it assists in converting the notch into a foramen, but not so much so elsewhere. Just below the anterior inferior spinous process, the acetabular head of the rectus femoris sends some tendinous fibres to it. Its base is broader than its margin, and is marked off from the articular cartilage by a crevice, or narrow groove, between them. Its acetabular side is covered by the synovial membrane: the other side has the capsular ligament adhering to it, and the third side adheres to the bone. Where it subtends the notch of

Fig. 92.



A lateral view of the ligaments of the Hip Joint and Pelvis. Right side. 1. The posterior sacro-iliac ligament of the pelvis. 2. The greater sacro-sciatic ligament. 3. The lesser sacro-sciatic ligament. 4. The greater sacro-sciatic notch. 5. The lesser sacro-sciatic notch. 6. The cotyloid ligament around the acetabulum. 7. The ligamentum teres. 8. The line of attachment of the capsular ligament of the hip joint, posteriorly. The ligament has been removed, in order to show the joint. 9. The obturator ligament.

the acetabulum, the cotyloid ligament is augmented by additional ligamentous fibres, placed beneath it, and going from the upper to the lower end of the notch: these fibres consist of two planes, one internal and the other external, partly crossing each other, and adhering closely to the cotyloid ligament.

The Inter-Articular, or Round Ligament (*lig. teres*) is a true ligamentous band, which is attached at the one end to the pit on the head of the os femoris, and afterwards, by a slight dissection, is easily separated into two fasciculi. Of these, the lower one may be traced to the inferior end of the cotyloid notch, where, winding around the prominence of bone, it begins to adhere to the ischium, and continues to do so from that point along the anterior face of the ischium, just below the acetabulum, to a point between the latter and the upper anterior part of the tuber. The other portion is directed towards the superior end of the notch, and is attached there by two extremities, one near the margin of the acetabulum, and the other three or four lines from it within.[1] The fibres of the round ligament are somewhat intermixed also with those of the cotyloid ligament subtending the notch.

The Capsular Ligament (*capsula fibrosa*) is the strongest in the body, and represents a conoidal sac, open at both extremities, by which it adheres to the bones. It is fixed by its base to the circumference of the acetabulum, beyond the cotyloid ligament, and into this ligament itself, where the latter subtends the notch. It embraces that part of the head of the os femoris which projects above the margin of the acetabulum, and descends along the neck to its root. It is longer in front; is fixed there to the oblique line which runs between the two trochanters, and, behind, into the root of the neck, a little in advance of the posterior oblique ridge for the quadratus femoris muscle, and in such a manner as to leave a small part, six or eight lines broad, of the neck of the os femoris, bare below it. Above, it is fixed to the neck, just below the rough fossa in the trochanter major; and on the under surface of the neck it adheres, just above the trochanter minor. It is strengthened in several places by processes from the fascia lata femoris, which descend to it between the muscles surrounding the hip joint.[2] Its thickness is considerable, but variable.

In front, and above, it is remarkably strong; is two or three lines thick, where it is augmented by a large fasciculus of fibres coming from the anterior inferior spinous process of the ilium (*ligament. ascititium*),

[1] Antonius et Caldani, Tabula II.

[2] Sœmmering, De Corp. Hum. Fabrica, vol. ii. p. 61, 1794. Andrew Fyfe, Compendium of Anat. Philad. 1807, vol. i. p. 179.

For an interesting account of the connection of this capsule with the fascia femoris, see Anatomical Investigations, by J. D. Godman, M. D., Philad. 1824. The author, in following the sheaths of the muscles, or, in other words, the processes of the fascia lata, between the muscles to the capsule, with great attention, has been brought to the conclusion that the capsule is formed entirely from them He has presented the same views in regard to the shoulder joint, and others. Though not disposed to concur in so general an inference on the source of capsular ligaments, inasmuch as their peculiar texture is opposed to it, and many other circumstances in their anatomical arrangement, yet these connections of the larger joints have been traced with an accuracy of great importance especially in relation to suppurations.

and descending, longitudinally, to the anterior oblique ridge of the os femoris. The internal and posterior portions of the capsular ligament are not so thick; it is, indeed, very thin near the posterior ridge of the os femoris, being not more than half a line, and has a number of holes in it for the passage of vessels. It is strengthened, internally, by some fibres coming from the superior margin of the thyroid foramen.

This capsular ligament keeps the bones closely applied to each other, and is by no means so loose as the corresponding one of the shoulder joint. Its fibres are very irregular, generally, in their course, and difficult to follow.

The strength of this articulation depends principally on the muscles which surround it, of which the rectus femoris, and the iliacus internus and psoas magnus united, are in front; between the latter two and the capsule, is a bursa mucosa. Within, are the pectineus and the obturator externus; behind, are the quadratus, the gemini, the obturator internus, and the pyriformis; above and behind, are the glutæi.

The Synovial Membrane is a complete sac, displayed over the articular surfaces of the bones and the internal face of the capsule. It is separated from the roughness at the bottom of the acetabulum, by the existence there of a pad of very vascular, fine, fatty matter, from which, according to Bichat, it may be raised by blowing beneath the ligament of the notch, at the point where the blood-vessels enter. Coming from the acetabulum, it covers the articular face of the cotyloid ligament, and is then reflected to the capsular ligament, to which it gives a polished internal surface, and from which it may be dissected. On reaching the root of the neck of the os femoris, it forms small longitudinal duplicatures, and is reflected upwards along the neck to the head, being separated from the neck by periosteum, or by a fibrous tissue, which M. Boyer considers a continuation of the capsular ligament. It covers all the head, except the point of attachment for the round ligament, and to the latter it gives a sheath, which, at the other end, is continuous with the part of the synovial membrane covering the fatty matter. From the latter circumstance, arises a deceptive appearance of the round ligament being inserted into the roughness in the bottom of the acetabulum.[1]

[1] I found, in a first instance, Dec. 10, 1838, the capsular ligament of this joint with a large opening, nine by eighteen lines, in front, and the synovial membrane communicating through it with the bursa between the trochlea of the ilium and the iliacus internus muscle. A similar arrangement existed on both sides of the body, everything else being normal. It was repeated in another subject, Jan. 2d, 1839, and has been observed in some instances since in our rooms. Such a condition must, of course, favor, under suitable circumstances, the internal dislocation of the os femoris. I attended a child a year old, with this dislocation, but whose parents were ignorant of the period of its occurrence, and which had been, at any rate, for some months previous. It appeared to me that the accident might have been produced by some trivial fall, coincident, possibly, with this peculiarity. It had been mistaken for paralysis by the medical advisers previously employed. The same child had a dislocation of the os humeri which seemed almost spontaneous, and could be reduced at once whenever it occurred, which was frequently.

Of the Knee Joint.

It is formed by the os femoris, the tibia, and the patella, the particular modelling of whose articular surfaces, for the purpose, has been described. These surfaces are all covered by a lamina of cartilage, and are held together by an apparatus which, for the number of its parts and their arrangement, makes this the most composite joint in the skeleton.

The most superficial layer of the knee joint is the fascia lata of the lower extremity, which, in passing down from the thigh to the leg, is so near the cavity of the articulation on each side of the tendon of the patella, that it is by Weitbrecht spoken of under the term of Common Investment (*involucrum generale*). It is here not only a continuation of the fascia femoris, but this fascia is increased and thickened by an aponeurosis, which springs from the inferior extremity of the extensor muscles on the thigh. The membrane thus formed covers both the patella and its ligament, and extends on each side to the lateral ligaments of the joint, to which it adheres; it may be traced even behind them, but there it becomes indistinct, loose, and blended with common cellular and adipose membrane. The involucrum adheres strongly to the internal and external condyles, and to the head of the tibia, from one lateral ligament to the other; it has oblique fibres on the patella, transverse ones on the ligament of the latter, and longitudinal ones on each side. It is in contact with the synovial membrane of the joint, except in the middle portion, where it is separated from it by the patella, and its tendon, and some adipose matter. It may be dissected without difficulty from the subjacent parts, by which the ligament of the patella, and the synovial membrane are brought into view.

Fig. 93.

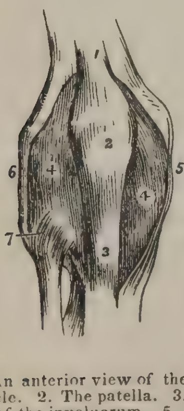


Fig. 94.

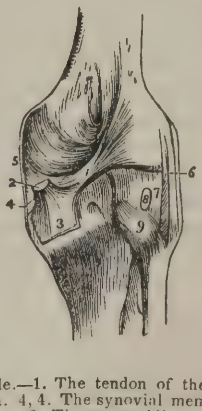


Fig. 93. An anterior view of the Knee Joint of the right side.—1. The tendon of the quadriceps femoris muscle. 2. The patella. 3. The ligament of the patella. 4, 4. The synovial membrane, after the removal of the involucrum. 5. The internal lateral ligament. 6. The external ligament. 7. The anterior ligament of the superior peroneo-tibial articulation.

Fig. 94. A posterior view of the Knee Joint of the right side.—1. The ligament of Winslow. 2. The tendon of the semi-membranosus muscle. 3. Its insertion, showing the expansion of its fibres 4. The portion which passes beneath the internal lateral ligament. 5. The internal lateral ligament. 6. The external lateral ligament. 7. A fasciculus of the same, sometimes called the short external lateral ligament. 8. The tendon of the popliteus muscle cut short. 9. The posterior superior peroneo tibial ligament.

The Ligament of the Patella being situated at the fore part of the articulation, though separated from the extensor muscles by the intervention of the patella, is, nevertheless, their tendinous insertion into the leg. It arises from the whole inferior margin of the patella, and is inserted into the tubercle of the tibia. It consists in longitudinal, closely compacted fibres, of a character entirely tendinous; the more superficial of them give a layer to the front of the patella, and in the fracture of the latter sometimes prevent a separation of its fragments. In front, as just mentioned, it is in contact with the involucrum; behind is a large pad of fat placed between it and the synovial membrane of the joint; and on the same surface, but lower down, it is in contact with a bursa mucosa fixed between it and the triangular flatness of the tibia above the tubercle.

A posterior ligament, an internal and an external lateral ligament, two crucial ligaments, two semilunar cartilages, and a synovial membrane, compose the remaining apparatus of the joint.

The Posterior Ligament (*lig. posticum*) is a fibrous expansion on the back of the knee joint, which may be considered as the proper capsular ligament at this point, and has its fibres extending obliquely from the external condyle of the os femoris to the posterior part of the head of the tibia. It is frequently called the ligament of Winslow, and by the French anatomists is considered as one of the divisions of the tendinous insertion of the semi-membranosus muscle, in consequence of its close connection with it. There are several foramina or interstices in it which permit a passage of blood-vessels to the fatty matter placed between it and the crucial ligaments, and beneath it there are some ransverse fibres.

The Internal Lateral Ligament (*lig. laterale internum*) is a flattened fasciculus of fibres placed at the internal side of the joint. It arises from the tuberosity on the inner side of the internal condyle, and descending vertically is slightly attached to the inner semilunar cartilage, and is then inserted into the superior margin and into the internal face of the head of the tibia for two inches or more, by increasing in breadth as it descends. On the one side it is in contact with the synovial membrane, and on the other, with the involucrum and the tendon of the sartorius and the gracilis. The semi-tendinosus is inserted under it, and it has the shape of a crotchet just at that point.

The External Lateral Ligament (*lig. laterale externum, longum*), placed on the external side of the joint, is nearer its posterior face than the internal ligament. It arises from the tuberosity on the outer face of the external condyle, above and behind the tendinous origin of the popliteus muscle, and is inserted into the external part of the superior extremity of the fibula, being covered in almost its whole extent by the tendon of the biceps. Its inner face is in contact with the synovial membrane, and the articular vessels. Its rounded form and shining appearance make it look very much like a tendon. Behind it occasionally is a small fasciculus, called by some the short external lateral ligament, which passes from the external condyle to the head of the tibia.

The Crucial Ligaments (*lig. cruciata*), two in number, are named from their crossing one another laterally, and thereby forming a figure resembling the letter X, or a Malta cross. They are situated at the posterior part of the articulation between the posterior ligament and the synovial membrane. One of them is called *anterior*, and the other *posterior*, from their relative situations to each other. The first arises from the internal face of the external condyle, by a depression near the posterior end of the notch and just at the margin of the articular surface; it descends forwards, and is inserted immediately in front of the little ridge between the articular faces of the tibia. The second arises from the bottom of the notch between the condyles, just behind the trochlea for the patella, upon a surface that may be considered as belonging to the internal condyle; it descends backwards, and is inserted into the rough surface behind the aforesaid spine or ridge of the tibia. The crucial ligaments are large, round, and composed of parallel fibres very closely compacted; their strength is very considerable, and they serve not only to limit the extension of the leg, but also to check anything like rotation inwards.

The Semilunar Cartilages (*cartilagines semilunares*, *falcatæ*) are two in number; one placed on either side of the superior face of the tibia, between it and the condyle of the os femoris. Their shape is sufficiently indicated by their names, and as they are placed on the circumference of each articular surface of the tibia, leaving the middle uncovered, they increase considerably the depth of the concavities for receiving the condyles. Their external circumference is thick, whereas, the internal is reduced by a gradual diminution of their thickness to a very thin edge; they thereby make movable glenoid cavities, which in every position of the leg are closely filled up by the condyles. The internal cartilage is but little more than a semicircle, and is longer in its antero-posterior diameter than in its transverse; on the other hand, the external is almost circular, an arrangement by which each is suited to its respective surface. They adhere by their greater circumferences to the fibrous matter surrounding the joint, particularly the lateral ligaments, but not so closely as to prevent their sliding backwards and forwards in the flexions of the leg. The tendon of the popliteus adheres to the external, either directly or by the intervention of a small synovial sac.

The internal semilunar cartilage is attached by its fore extremity to the anterior internal side of the roughness, in front of the ridge called spinous process, on the top of the tibia; and by the hind extremity to the posterior face of the base of the ridge, just in advance of the posterior crucial ligament. The external cartilage is attached by its anterior end, also to the roughness in front of the ridge; but this attachment is considerably behind the corresponding one of the internal cartilage, and is somewhat blended with the anterior crucial ligament: the posterior end is fixed into the depression on the summit of the ridge or spinous process, and is there between the two crucial ligaments. The external sends a flat slip outwards to be attached to the head of the fibula, and over this slip, which is a movable trochlea, plays the tendon of the popliteus muscle. The anterior extremities of the two

cartilages are united by a transverse ligamentous fasciculus a line in thickness, which is rather inconstant; but when found, is in front of the anterior crucial ligament. These bodies, though presenting an appearance corresponding with cartilages, on their surface, are nevertheless formed principally from concentric ligamentous fibres; the character of which is very evident at their extremities, and when they are lacerated.

The Synovial Membrane is thin, loose, and delicate, and, as in other joints, is a perfect bag, covering the articular faces of the bones, and reflected from the one to the other. As there is no regular capsular ligament to the knee joint, the synovial membrane is very distinct on each side of the tendon of the patella, and comes in contact there as stated with the fascia lata, or involucrum, as it passes from the thigh to the leg. The synovial membrane, after covering the articular faces of the tibia, is reflected from their margin upon the semilunar cartilages, so as to invest their inferior and superior surfaces; it then ascends to the condyles of the os femoris. It covers the condyles, laterally, as well as on their articular faces, and leaves thereby half an inch or more of their circumference on each side of the trochlea of the patella, included in the periphery of the joint. The synovial membrane, anteriorly, being separated from the tendon of the patella, by the large pad of fat there, then covers the posterior face of the patella, and rising up still farther, lines the posterior face of the tendons of the extensor muscles for the distance of three inches or thereabouts. The superior end of this reflection is formed into a small pouch communicating freely with the general cavity, but marked off from it by a partial and variable septum on each side. Some anatomists consider the pouch as a bursa, but it is so seldom seen entirely distinct from the joint, that it answers better to describe it as a part only of the general reflection. The synovial membrane, at the sides of the joint, is in contact with the lateral ligaments. Behind, it is reflected on the anterior surface of the tendinous origins of the gastrocnemius, and envelops the tendon of the popliteus; it also invests the crucial ligaments, but in such a way as to leave them out of its cavity.

The collection of fat behind the tendon of the patella forms, just below the latter, a ridge on each side, protruding into the articulation, and having a fringed summit formed by a doubling of the synovial membrane. The external ridge is the Ligamentum Alare Minus Externum, and the other the Ligamentum Alare Majus Internum. These ridges unite at their lower extremities, and from their place of union proceeds a flattened conical process of the synovial membrane, in front of the anterior crucial ligament; the point of this process is attached to the posterior extremity of the groove, in the middle of the trochlea for the patella. This duplicature is the Mucous Ligament (*ligamentum mucosum*). There are in fact four fringed doublings of the synovial membrane visible in this region, two above, and two below, and corresponding with what are called the glands of joints. The two superior being each on its respective side of the tendon of the patella are narrow and superficial, and converge so as to unite at their inferior extremities. The two below, which are the ones alluded to in the pre-

ceding description as Lig. alaria, are more horizontal in their course and much larger, have a more striking connection with the ligamentum mucosum, and they serve especially to fill up the interstice between the condyles of the os femoris and the head of the tibia.

Of the Peroneo-Tibial Articulation.

The tibia and the fibula are held together by three places of union, one above, another below, and, thirdly, the ligament which fills up the space between the bodies of the bones.

1. The Superior Articulation, formed by the upper extremity of the fibula and the outer side of the head of the tibia, is entirely disconnected with the cavity of the knee joint, and has nothing in common with its apparatus, except the external lateral ligament, which has been described. The articular faces are small, and covered with cartilage; an anterior and a posterior ligament, and a synovial membrane, hold the bones together at this point.

The anterior ligament is attached by one end to the front of the head of the fibula, and proceeding upwards and inwards, is inserted by the other into the contiguous part of the head of the tibia, before the articular facet. The fibres are separated into fasciculi, leaving interstices between them for cellular substance.

The posterior ligament is narrower than the anterior; but its fibres are more compact, and, like the anterior, they observe a transverse course; being attached by the one end to the head of the fibula, and, by the other, to the head of the tibia. The popliteus muscle covers it. This joint is also strengthened by other ligamentous fibres, and by the insertion of the tendon of the biceps.

The synovial membrane is reflected over the articular faces and the ligaments described, and has nothing of particular interest in it. Occasionally, the synovial membrane of the knee joint runs into it.

2. The Inferior Articulation, which is formed between the lower extremities of the bones, is not incrusted by cartilage, except to the breadth of a line at its lower part, bordering on the ankle joint.

The anterior ligament is broad, and covers the face of the bones which are in apposition. Attached by the one side to the front of the lower extremity of the fibula, its fibres pass obliquely upwards and inwards, to be inserted into the corresponding part of the tibia. Several interstices exist in it for the passage of vessels, and it is covered by the peroneus tertius. Its lower margin is in contact with the astragalus, and forms a portion of the ankle joint.

The posterior ligament, in the arrangement and course of its fibres, corresponds with the anterior; being attached by one side to the posterior face of the fibula, and by the other to the corresponding part of the tibia. Like the other, its fibres are longer near the ankle joint than above. Its lower margin is in contact with the astragalus, and is connected with other ligaments coming from the fibula.

In the space between the anterior and the posterior ligament, where the bones touch, they are agglutinated by a short, strong, fibrous tissue,

leaving intervals occupied by adipose matter. It contributes much to the solidity and immobility of this articulation.

3. The Interosseous Ligament (*membrana interossea*) is analogous to that in the fore arm, by being a membrane stretched between the two bones. It arises from the ridge on the outer face of the tibia, and is attached to the corresponding ridge on the inner face of the fibula. It is broader above than below, being at the latter point continuous with the fibrous structure which agglutinates the bones. Just below the head of the fibula is a large hole for transmitting the anterior tibial vessels, and the origin of the tibialis posticus muscle. It also presents, in its descent, several smaller foramina for the passage of vessels. Its fibres are strong and unyielding, and run obliquely downwards from the tibia to the fibula. It is covered in its whole length, both before and behind, by muscles, and serves as an origin to them and as a means of attachment between the bones.

Of the Ankle Joint.

The articular surfaces, here, being covered by cartilage as in other movable joints, are formed by the astragalus being received into a deep cavity made by the tibia and the fibula. The capsular ligament, properly speaking, does not exist either on the front or back of the joint, and is represented, there, by a few scattered, loose fibres, on the periphery of the synovial membrane. An internal and an external lateral ligament, with the synovial membrane, constitute the whole apparatus.

The Internal Lateral Ligament, also called the Deltoid (*lig. deltoideum*), arises from the whole inferior margin of the malleolus internus, and with particular strength from the depression which exists in it: it then descends and is inserted into the internal face of the astragalus, and into the lesser apophysis of the os calcis, which lies just below it, being also strongly attached at its anterior part to the Internal Calcaneo-

Fig. 95.

Fig. 96.

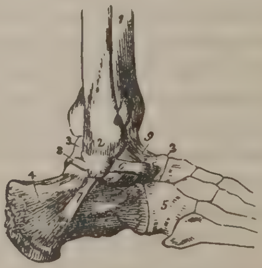


Fig. 95. An internal view of the Ankle Joint of the right side.—1. Internal malleolus. 2, 2. Part of the astragalus, the rest being concealed by ligaments 3. Os calcis. 4. Scaphoides 5. Internal cuneiform bone 6. Internal lateral, or deltoid ligament. 7. The synovial capsule, covered by a few fibres of a capsular ligament. 8. Tendo-Achillis.

Fig. 96. An external view of the Right Ankle Joint.—1. The tibia. 2. The external malleolus of the fibula. 3, 3. The astragalus. 4. The os calcis. 5. The cuboides. 6, 7, 8. The anterior, middle, and posterior fasciculi of the external lateral ligament. 9. The imperfect capsular ligament.

Scaphoid Ligament. This internal lateral ligament is broad, thick, quadrilateral, and composed of fibres which descend obliquely backwards. The tendon of the tibialis posticus runs in a trochlea which is formed on the internal face of this ligament.

The External Lateral Ligament (*lig. triquetrum*) consists in three distinct fasciculi, of which one is anterior, another posterior, and the third in the middle. The anterior arises from the lower extremity of the malleolus externus, and running inwards and forwards, is inserted into the outer face of the astragalus in front of the surface for the fibula. The posterior arises from the depression in the extremity of the malleolus externus, and, running inwards and backwards, is attached to the point of the astragalus, at the outside of the groove, for the tendon of the flexor pollicis pedis. The middle arises from the pointed termination of the malleolus externus, and descending beneath the tendons of the peronei muscles, is attached to the external face of the os calcis, below the surface for the astragalus. These fasciculi are composed of strong longitudinal and parallel fibres. The posterior is larger than either of the others, and occasionally detaches a part which is inserted into the posterior margin of the articular face of the tibia.

The Synovial membrane is reflected, as usual, over the articular surfaces, and from one bone to the other. It sends up a short process of a line in length between the tibia and the fibula, it is remarkably loose in front and behind, and has on its superficial face a considerable quantity of adipose matter, which cannot be easily detached from it. It commonly contains an unusual quantity of synovia.

Of the Articulations of the Foot.

Of the Tarsal Articulations.—1. The Os Astragalus is united to the Os Calcis by a double articular surface, which has been described. The ligaments which hold them together are as follows.

The Interosseous Ligament is placed between the two bones, so as to occupy the large oblique fossa between the double articular surface in each. It is a collection of very strong, short fibres, with interstices for fatty matter, and which, arising from the whole length of the groove in the astragalus, descends to be inserted into corresponding points in the groove of the os calcis. Where the fossa is narrow, as it is behind, the ligament is thin and flat, but it augments considerably in front, where there is more room for it.

The Posterior Ligament arises from the posterior margin of the astragalus, and, descending obliquely inwards, is inserted into the adjacent portion of the os calcis. Its fibres are blended with those of the Deltoid Ligament, and on their posterior face they form a ligamentous trochlea for the tendon of the flexor longus pollicis pedis.

This articulation is also strengthened by the insertions stated of the lateral ligaments of the ankle joint into the os calcis.

The Synovial membrane forms a distinct cavity on the posterior and larger articular face of the two bones, and is in contact with the fatty matter in advance of the tendo-Achillis.

2. The Articulation of the Astragalus with the Scaphoides is formed by the convex head on the part of the former, and by the concavity on the part of the latter. It is covered above by a thin, broad ligament, with parallel and oblique fibres, which, arising from the superior and internal face of the astragalus, are implanted into the upper face of the scaphoides, some of its fibres extending over to the cuneiform bones. It is covered above by the tendons of the extensor muscles of the toes, and of the tibialis anticus.

On the under surface of the foot, this articulation is supported by two ligaments, called the Calcaneo-Scaphoid (*lig. plana*), from their origin and insertion. The *Internal* one arises from the internal margin of the lesser apophysis of the os calcis, and running obliquely forwards and inwards, is inserted into the under and internal surface of the os scaphoides. It is a very thick, flattened fasciculus, on the under surface of which is formed the ligamentous trochleæ, in which run the tendons of the flexor longus pollicis and flexor longus digitorum, and which surface is also in contact with the tendon of the tibialis posticus. By subtending the head of the astragalus, the Internal Calcaneo-Scaphoid Ligament contributes largely to keeping it in place, in the erect position. The *External* Calcaneo-Scaphoid Ligament, placed at the outer margin of the last, arises from the under surface of the greater apophysis of the os calcis, and running obliquely inwards and forwards is implanted into the under external surface of the scaphoides. It consists in two or more short, strong fasciculi.

Fig. 97.

A view of the Ligaments of the Sole of the Foot, left side. 1. The under surface of the os calcis. 2. The astragalus. 3 The scaphoides. 4, 5. The two planes of fibres of the calcaneo-cuboid ligament. 6. The calcaneo-scaphoid ligament. 7. The plantar ligaments. 8, 8. The peroneus longus tendon. 9, 9. The tarso-metatarsal plantar ligaments. 10. The capsular ligament of th first joint of the big toe. 11. The lateral ligaments of the first joints of the toes. 12. The transverse ligament. 13. Lateral ligaments of the last joints of the toes.

The Synovial Membrane of the articulation between the astragalus and the scaphoides covers the articular faces of these bones and lines the ligaments above and below. A reflection of it also lines the articulation between the os calcis and the astragalus, in front of the rough fossa which is occupied by their interosseous ligament.

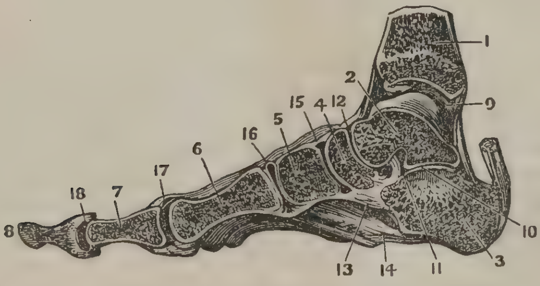
3. The Calcaneo-Cuboid articulation, formed by the two bones indicated in the name, is maintained by two ligaments, one above, the other below, and by a synovial membrane.

The Superior Calcaneo-Cuboid Ligament arises from the upper anterior surface of the os calcis, and is inserted into the adjoining upper surface of the cuboides. It is broad, thin, and quadrilateral, with short parallel fibres, and is in contact above with the peroneus tertius tendon.

The Inferior Calcaneo-Cuboid Ligament (*lig. plantare*), placed on the plantar surface of the foot, is remarkable for its size and extent. It consists of two horizontal planes of fibres, of which the superficial is the longer. The latter arises from the back under surface of the os calcis, and advancing forwards, its fibres are inserted into the summit of the ridge which traverses the cuboides obliquely; the greater part of them, however, go beyond this point, and, dividing into fasciculi, are inserted into the base of the fourth and fifth metatarsal bones. The tendon of the peroneus longus is confined between these fasciculi and the under surface of the cuboides. The other plane of this ligament, being more deeply seated, is also shorter. It arises from the front under surface of the os calcis, where the tuberosity exists at this point, and, by advancing, is inserted entirely into the oblique ridge of the cuboides.

The Synovial Membrane being reflected over the articular surfaces

Fig. 98.



A vertical section of the Ankle Joint and Foot of the right side. 1. The tibia. 2 The astragalus. 3 Os calcis 4 The scaphoides 5. The cuneiforme internum 6 The metatarsal bone of the great toe 7 The first phalanx of the great toe 8 The second phalanx of the great toe. 9 The articular cavity between the tibia and astragalus, with its articular adipose matter. 10. The synovial capsule between the astragalus and calcis. 11. The calcaneo-astragalien interosseous ligament. 12. The synovial capsule between the astragalus and scaphoides 13 The calcaneo-scaphoid ligament 14. The calcaneo-cuboid ligament. 15. The synovial capsule between the scaphoides and cuneiforme internum. 16 The synovial capsule between the cuneiforme internum and the first metatarsal bone. 17 The metatarsal-phalangial articulation of the great toe, with the sesamoid bones below. 18. The phalangial articulation of the great toe.

of the bones, and lining the ligaments, is uncovered at several places above where interstices exist between the fibres of the superior ligament, and externally it is contiguous to the tendon of the peroneus longus.

4. The Scaphoid and the Cuboid bones touch at the external posterior angle of the cuneiforme externum, and form there, occasionally, a distinct articular surface with a synovial membrane. Besides this mode of union, an interosseous ligament is introduced between them. On the dorsum of the foot there is a transverse ligament running from one bone to the other beneath the extensor tendons, and on the sole of the foot there is an oblique ligament, which, arising from the under surface of the scaphoides, is inserted into the anterior internal margin of the cuboides.

The articular surfaces of the Cuboides and Cuneiforme Externum, which are in contact, besides a distinct synovial membrane, are secured by transverse and oblique ligamentous fibres going from the one bone to the other.

5. The Articulation between the scaphoides and the three cuneiform bones is secured by dorsal and plantar ligaments. The dorsal, arising from the back of the scaphoides, is in three fasciculi, that go respectively to the back of each cuneiform bone; of them the internal is the strongest, and is particularly well marked on the internal face of the cuneiforme internum. The plantar ligaments are, also, three in number, and having a sort of common base from the under surface of the scaphoides; by being divided into three fasciculi, as the above, are inserted into each cuneiform bone. They are not so well marked as the upper ones.

The cuneiform bones are also connected together above and below, by short transverse ligaments going from one bone to the other, and holding their lateral surfaces in contact. Those below are not so distinct as the upper ones, and are blended with the insertions of the tibialis posticus.

One synovial membrane covers the articular surfaces of the scaphoides and of the cuneiform bones which are in contact; and it extends itself by digital processes between the first and second, and the second and third cuneiforms, so as to line also the articulations there. The process between the latter two is much shorter than the process between the former two, which extends itself into the tarso-metatarsal articulations, after the same principle which is observable in the hand.

Of the Tarso-Metatarsal Articulations.

The articular faces of the bones, here, having been sufficiently described, it is to be noted in addition, that besides being covered with cartilage, they have the apparatus of the movable articulations generally, in ligaments which hold them together, and in synovial membranes. The ligaments are above and below.

1. The articulation of the first metatarsal bone with the cuneiforme internum is one-third of an inch in advance of the next, and completely insulated by its synovial membrane: it is strongly secured by ligamentous fibres above, internally and below, which give it almost a complete capsule.

2. The dorsal or upper ligaments of the remaining metatarsal bones are arranged as follows. There are three for the second metatarsal; one comes from the second cuneiform, one from the first, and another from the third; the latter two are oblique, and they all converge to be inserted into the base of the bone to which they belong. One dorsal ligament passes from the third cuneiform to the base of the third metatarsal; it is sometimes assisted by a fasciculus from the cuboides. From the superior face of the cuboid bone a fasciculus is sent to the base of the fourth and fifth metatarsals.

The plantar or under ligaments are arranged on the same plan with the dorsal. Not being quite so strong, they are augmented by the fibrous sheaths of the flexor tendons which lie upon them.

The synovial membrane, which is reflected over the articular surfaces between the second and third metatarsals and their corresponding cuneiforms, is the elongation of the digital process sent from the scaphoid articulation, between the first and second cuneiforms. This process, besides extending to the aforesaid tarso-metatarsal articulations, insinuates itself to the articular surfaces on the sides of the second metatarsal bone; but a distinct synovial capsule is sometimes formed between the base of the third and fourth metatarsals.

One synovial membrane is reflected over the surfaces, between the cuboides and the last two metatarsals, and sends in a process between the latter. In all these cases the synovial membranes line the dorsal and plantar ligaments of their respective articulations.

Of the Metatarsal Articulations.

The metatarsal bones, with the exception of the first, articulate with each other by the contiguous faces of their roots, as has just been stated, along with the manner of their getting, at these points, a lining of synovial membrane. They are farther fastened to each other by short transverse ligamentous fasciculi, which pass from the base of one to the base of the adjoining. These fasciculi exist both on the upper and under surface of the bones, are, therefore, denominated dorsal and plantar metatarsal ligaments. There is also a description of interosseous ligament between the bases of these bones, occupying the space intermediate to the dorsal and plantar ligaments of each.

The anterior extremities of the metatarsal bones are not in contact; they are, however, fastened to each other by a transverse or Anterior Plantar Ligament on their under surface, the fibres of which are somewhat blended with the capsular ligaments of the first joints of the toes.

Of the First Joints of the Toes.

The surfaces of the bones here being covered with cartilage, are formed into an arthrodial articulation. There is a fibrous capsule surrounding the articular faces, and enclosing the synovial membrane. This capsule is considerably thickened below, where the flexor tendons pass over it; above, it does not exist, as the extensor tendon is there lined by the synovial membrane. On each side is a lateral ligament, but much weaker than the corresponding ligament of the fingers. In the great toe the external lateral ligament is frequently inserted into the outer sesamoid rather than into the first phalanx, and is sometimes almost wanting. In the under part of the capsule of the great toe, we find on each side a sesamoid bone.

These joints resemble so strongly the corresponding joints of the fingers, that a farther description is unnecessary.

Of the Second and Third Joints of the Toes.

From the shape of the surfaces of the bones composing them, these are simply ginglymous articulations. They have their cartilaginous incrustations, synovial membrane, and capsular ligament. The under part of the latter is much thickened, and forms a trochlea for the flexor tendons, and above it is defective, as the synovial membrane is in contact with the extensor tendon. On each side is a lateral ligament. These joints also resemble so strongly the corresponding ones of the fingers, that farther description is unnecessary.

BOOK II.

OF THE INTEGUMENTS OF THE BODY.

The integuments consist in Cellular and in Adipose Substance, and in the Dermoid Covering.

PART I.

Histology of Cellular and of Adipose Substances.

CHAPTER I.

OF THE CELLULAR SUBSTANCE.

The Cellular Substance (*textus cellulosus*, *mucosus*) also called Areolar Tissue, Uniting Amorphous Tissue, Connective Tissue, Conjunctive Tissue, is an elementary one, and is more generally diffused than any other of the body, for it seems to be quite as indispensable to the latter as the corpus mucosum is to vegetables. It is found abundantly beneath the skin; between muscles; in the interstices of muscles and of other parts; connecting membranes to one another; surrounding organs; entering into their composition; gluing them together; in fine, under every variety of circumstance and of locality which the human organization admits. Indispensable as it is to the texture of all other parts, we find it, as may be expected, preceding them in the development of the fœtus; at which period it is in the condition of a fluid slightly inspissated.

It is remarkable for its whiteness, translucency, and flexibility. When examined with a microscope, as it winds around a muscle and introduces itself between the fasciculi of its fibres, it will be seen that, however fine the latter may be, yet this tissue is interposed between them in thin laminæ. On separating these fibres, the intervening laminæ are resolved or drawn out into fine filaments, which, finally, break after being stretched to a certain extent. The lamina which surrounds the whole body of the muscle, and constitutes its sheath, on being put upon the stretch, tears only after having been attenuated into still thinner laminæ and into fibres.

If air be blown into the sheath of a muscle, this sheath is distended into a multitude of cells of various forms and sizes, which have no determined shape, and do not, upon the expulsion of the air, return to the same shape upon a repetition of the inflation. Such cells communicate very freely; all limpid fluids pass with the greatest ease from one to the other, so that from any single point they may, by the force of injection, be distributed throughout the body; this is manifested in emphysema, where from a small wound in the thorax, air becomes universally diffused. Fluids of any kind, except they be inspissated, when deposited in these cells, are subject to the common laws of gravitation, and continue to descend successively from the higher to the lower cells, as in anasarca. Blood traverses them very readily in ecchymosis.

Cellular tissue enjoys a good deal of elasticity, for when stretched it readily returns upon itself. When very thin, as between the fibrillæ of muscles, it is colorless or nearly so, and of a gelatinous or glue-like consistence; but when its laminæ are thicker, it is of an opaque white, and has a strength amounting almost to that of ligamentous matter. When dried it becomes crisp and of a dark brown; but may be restored to its color and condition by soaking in water. It is only very slightly affected by the usual heat of the culinary processes of roasting or boiling, as our dishes of meat daily prove; but may be resolved into gelatin after a protracted ebullition. Its putrefaction is slow, and cannot be accomplished, by maceration, under a considerable lapse of time, depending much, however, upon the season of the year, and other circumstances.

The cellular substance is pervaded by a large number of blood-vessels, the majority of which do not, in a natural state, convey obviously red blood; but if any portion of it be exposed for a short time to the air, or to any other unusual stimulus, it quickly becomes suffused with red blood, circulating through an infinitude of channels. It cannot, however, be conceded, as Ruysch supposes, that it is formed exclusively of blood-vessels. Some anatomists, indeed, as Haller and Prochaska, allow that though blood-vessels ramify through it, yet they are not spent upon it, or do not form a part of its organization. The distinction is rather too subtle to be readily admitted, and seems, moreover, to be refuted by the continued exhalation and absorption which are going on within. It does not appear that nerves are spent upon the cellular substance, though they pass abundantly through it, as a blastema, to their respective organs.

It is probable that the granulations upon which injured parts of the body depend for their restoration, arise from this cellular substance. It abounds in lymphatic trunks as they pass along from different parts of the body, and has no doubt an intimate connection with the absorbent system, though there are great difficulties in detecting the mode. The late Professor Wistar attended a patient for compound fracture of the leg, with a large wound, which was subsequently covered with luxuriant granulations. The limb was suddenly attacked with an œdematous swelling, which extended itself to the sore, and caused its granulations to tumefy, so that they pitted upon pressure precisely like other parts.[1]

[1] System of Anat. vol. i. p. 388, 2d edition.

The most generally received opinion of anatomists,[1] in regard to the arrangement of cellular tissue is, that it results from the assemblage of a multitude of lamellæ, and of fine soft filaments, which being variously interwoven, produce a series of cells all communicating one with another, but varying in their shape and size: so that the whole cellular substance may be considered to represent a single cavity subdivided into an infinitude of smaller ones. To this it is objected,[2] that when this tissue is accurately examined, it appears rather as a homogeneous, viscid, and only partially solidified substance; particularly in the inferior orders of animals, and in the embryo state of the more exalted, where it has still to admit the deposite or formation of the several organs. That the same is manifested at any period of life, for neither with the naked nor assisted eye does it assume any other appearance. That its laminated and filamentous condition, when such does appear, is owing to its glutinous or glue-like consistence, which causes it to assume a factitious arrangement upon being drawn or inflated. For example, if one separates two muscles for a short distance, the cellular substance between them becomes unequal and furrowed, without losing its cohesion; but if they be farther separated, filaments and cylindrical columns are produced. If the traction be then suspended, and the muscles replaced, the filaments shorten, and are finally united into a consistent mass whose parts all adhere together.[3]

While such tractions are going on, it most frequently happens that air is insinuated into the cellular substance, from which comes the appearance of small cells and vesicles; upon the escape of this air, the primitive state of cohesion is restored, and upon a renewal of the traction, cells of a different shape, size, and appearance arise. Again, if air be so introduced, one may push it in any direction, separate its globules, collect them again, and into larger masses; vary their shape, and, in fine, by such means mould the supposed cells into an infinity of forms. From these considerations, the inference is plain, that when the cellular substance is drawn, it must yield itself into filaments; when inflated, as the air acts in every direction, its supposed lamellæ must be separated and assume a cellular shape; and, by the application of both forces at once, it may be caused to assume both a cellular and a filamentous appearance. Upon the whole, Meckel conceives that the term Mucous Tissue, adopted by Bordeu, is much more exact than the one of Cellular Tissue, now most generally used.

Notwithstanding the general similarity of cellular substance where-ever found, there is a well marked difference between portions of it, for example, the intermuscular and subcutaneous cellular substance, when inflated and dried, remains permanently lamellated, whereas, that which makes a regular tunic to the alimentary canal and other hollow viscera, when treated by the same process, is permanently filamentous and resembles so much, carded cotton, that at a little distance their appearance is almost identical. The lamellated is also much more

[1] Haller, Béclard, Bichat, Wm. Hunter, &c.

[2] Bordeu, Récherches sur le Tissue Muqueux et Celluleux, Paris, 1790. J. F. Meckel, Manuel D'Anat. vol. i. p. 105.

[3] J. F. Meckel, loc. cit.

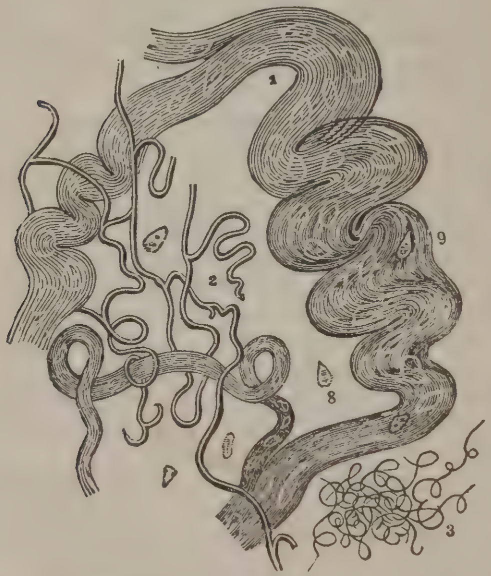
glutinous to the touch and sight than the filamentous. The filamentous cellular substance is, in its normal condition, in many places free from fat cells, a disposition indispensable to the preservation of the cavities to which it belongs.

The preceding details exhibit the condition of cellular tissue as seen by the naked eye, but under the microscope some modifications are evident. For example, it is found to be made principally of very attenuated filaments from the $\frac{1}{25000}$th to the $\frac{1}{15000}$th of an inch in thickness, which are united into bundles and into laminæ. These filaments do not divide into branches or unite one with another, but each one keeps distinct, though it runs parallel with the contiguous ones, in the same bundle. Their course is also serpentine or wavy, which may be corrected on stretching, but returns again on the cessation of the force.

The filaments above are transparent to transmitted light, but of a white color to reflected light. They are of a dense milky whiteness when collected in thick masses to form tendons, ligaments, and other white fibrous textures. In the intervals of these filaments, is found an extremely delicate amorphous or hyaline membrane.

Associated with these parallel filaments of cellular tissue, there are

Fig. 99.



The two elements of Areolar Tissue, in their natural relations to each other.—1. The white fibrous element, with cell-nuclei, 9, sparingly visible in it. 2. The yellow fibrous element, showing the branching or anastomosing character of its fibrillæ. 3. Fibrillæ of the yellow element, far finer than the rest, but having a similar curly character. 8. Nucleolated cell-nuclei, often seen apparently loose. —From the areolar tissue under the pectoral muscle, magnified 320 diameters.

fibres of yellow elastic tissue not so abundant, but which may be rendered visible by acetic acid, which makes the white fibres swell up and become indistinct. The yellow fibres under the microscope are transparent and colorless, and have a strong, dark, well-defined outline.

They curl up especially at their broken ends, divide into branches and join or anastomose, in the same way with the fibres of the purest elastic tissue. For these causes they are considered identical with it. Some are very small, others large; they lie for the most part without order in the midst of the white fibres, but sometimes encircle them. These yellow elastic fibres abound in the sub-serous and sub-mucous cellular tissue.

The cellular tissue like all others, pre-exists in the condition of a homogeneous formative mass called cytoblastema, which corresponds in animals with the gum so abundant in the nascent parts of plants. This gum or cytoblastema appears to become, according to the observations of Schleiden,[1] turbid from the evolution of minute molecules. In a short time larger molecules are noticed. The secondary molecules augment in size by agglomeration or coagulation, and in that state constitute cytoblasts, in which the secondary granules are visible as nuclei. A cytoblast finally reaches its full size, and then a small vesicle appears on it, which enlarges and becomes a cell. The cytoblast is more or less permanent, and is for some time visible either attached to the interior of the cell or free in its cavity. The observations of Schwann are admitted to have proved the exact identity of the process described, as compared in plants and in animals. The process of primitive evolution, therefore, in every case exhibits the stages of nucleoli, nuclei or cytoblasts, and germinal cells surrounding the latter. Mirbel had previously shown that the ultimate form of all vegetable tissue was that of cells.

In the earlier stages of the cell, it bears the relation to the cytoblast which a watch glass has to the watch, but finally enlarges so as to enclose it. Some nuclei are permanent, but others finally disappear entirely. The cells thus formed have others developed in their interior,

Fig. 100.

Fig. 100 represents an organic cell of the developing Areolar Tissue, isolated and highly magnified, undergoing the division of the extremities of its prolongations into the ultimate filamentary structure.

[1] Müller's Physiology, p. 49, Bell's edition.

which by their reciprocal pressure become polyhedral. The cells of cellular tissue pass from the above nascent state into one of an elongated spindle-like shape, having its extremities resolved into fine filaments. The filamentous structure finally invades the whole cell except the nucleus, and the transformation is now complete by its running into similar adjoining filaments.[1]

The cellular tissue is remarkable for the celerity of its reproduction when lost by accident. The process is the same as in the nascent state.

Notwithstanding the perfect continuity of the mucous or cellular substance throughout the body, anatomists for the ease of description have divided it into External and Internal.

The External Cellular Substance (*textus cellulosus intermedius, seu laxus*) has the general extent and shape of the body and of its organs, so that if it were possible to extricate the latter from their envelop, it would present a chamber for the lodgment of each part. But the walls of these chambers would not all be of the same thickness, as the quantity of cellular substance varies. In the cranium and spinal cavity there is very little of it: on the surface of the head and in the orbits, more: about the trunk, both internally and externally, it is abundant; in the extremities still more so, where it penetrates between the muscles. In the arm pit, in the groin, and in the neck, all parts where much motion is enjoyed, it is unusually abundant. The foramina of the cranium and of the spine establish the points of connection of the cellular substance of these parts with others adjacent. The cellular substance of the face is continued into that of the neck; that of the latter is continued through the upper opening of the thorax upon the viscera of this cavity; and thence through the openings of the diaphragm, along the great vessels and œsophagus upon the viscera of the abdomen and pelvis. The cellular substance of these cavities is again continuous with the deep-seated cellular substance of the limbs at the arm pit and at the groin. The trunk of the body being enveloped by one broad sheet of cellular substance, it is continued superficially to the limbs.[2]

With this general sketch of the distribution and extent of cellular substance, it is not surprising that, in certain bad cases of emphysema, the air shows itself everywhere, even at points the most remote from the lungs, and apparently the least exposed to the accident, as the interstices of muscles, of glandular organs, and so on. It will also now

[1] The above subject has also been treated of with great perspicuity by Valentin, who has investigated closely these primordial laws of growth. The umbilical cord of the fœtus of about seven weeks is considered, by Dr. Leidy, very favorable for observing the development of cellular tissue. Quain and Sharpey, p. 232, vol. i.

Dr. M. Barry advances the opinion that the blood-corpuscles or globules are the nuclei or cytoblasts of the primitive cells, from which all the animal tissues arise. The crystalline lens he considers one of the best proofs of this conversion. Phil. Trans., 1840–41.

[2] For a detailed account of the inflections of the cellular substance, the student may consult with advantage, Bordeu, loc. cit. These inflections are the Fasciæ of modern Surgical Anatomy.

Bichat, Anatomie Générale; Système Cellulare, Paris, 1818.

Andreas Bonn, de Continuationibus Membranarum, in Sandifort's Thesaurus Dissertationum, Rotterdam, 1769.

Haller, Element. Physiol. vol. i. 1757.

be understood how this varied distribution of cellular substance and its modified texture, have been the inexhaustible but delusive source of anatomical discoveries and supposed novelties, under the name of fasciæ, sheaths of vessels, and so on; and will continue to be so, to such as do not recollect that all such things are included under the general character of this tissue; and that each muscle, each viscus, each nerve, and each blood-vessel, has its own particular chamber under this multiform arrangement, which chamber may be traced to or from any other point, according to fancy. At the same time it should be noted that many of the laminæ have a condensed form, which renders a special knowledge of them of the greatest use to the surgeon, and which is elsewhere succinctly pointed out, with the description of the respective organs.

Anatomists who lived at a period much less illuminated than the present on the subject of the elementary tissues of the body, seem to have seized upon the idea of the universal inflection of cellular substance over the surface, and through the texture of the several organs. Mangetus,[1] without pretending to originality, but in alluding freely to the observations of others, says, "Membrana adiposa, est expansio cellulosa, quæ totum corporis habitum, paucissimis, iisque minimis partibus exceptis, circumambit; et in quâ materia albicans unctuosa, sensu expers, ad partes fovendas ac lubricandas colligitur.—Hæc membrana cellulosa seu pinguedinosa, non tantum in exterioribus corporis reperitur; sed interius in intestinis, mesenterio, aliisque prope omnibus partibus, non exceptis etiam vasis sanguiferis, ut suo loco videbimus, observatur." And in describing the aponeurotic covering of the body and of the limbs, which in his day was called Membrana Musculosa, from some false notions of its nature, he adds, "Dicitur oriri a dorsi vertebris, quia scillicet earum spinis firmiter adhæret, inibique multo quam alibi usquam robustior conspicitur. Usus est, musculos universim in sua sede firmare, iisque quasi thecam præstare, in qua ut supra innuimus laxius sibi cohærente, lubricè moveri queant." The cellular investments of the muscles the same author calls Membrana Musculi Propria, and he speaks of their penetrating between the fasciculi of muscles, and most evidently those of the glutæus magnus and deltoides.

The Internal Cellular Membrane (*textus cellulosus stipatus*) presents itself under different arrangements according to the organ or part whose interstices it penetrates. As it forms in the muscles an envelop for each fasciculus and fibre, if the latter by any art could be withdrawn, it would represent a congeries of fine parallel tubes. In the case of glandular bodies the internal cellular membrane imitates the shape of their lobes, lobules, and acini or small graniform masses, and may, therefore, be compared to a sponge. In the hollow viscera, as the stomach and bladder, it unites their successive laminæ to one another. In the ligaments, even where the fibrous structure is perfectly evolved, the fibres are united by cellular tissue in their interstices. This tissue is not sufficiently abundant in the bones, tendons, or cartilages, to be very distinct; but from what is seen of it in the forming

[1] Theatrum Anatomicum, Geneva, 1716, vol. i. ch. iii.

stage of the embryo, it is nevertheless ascertained to be the base of every part. In glandular textures it is frequently spoken of under the name of parenchyma in connection with their acini.

Most of the membranous textures of the body may by maceration be resolved into this pulpy or cellular tissue, so that anatomists, without hesitation, assert that, under various degrees of consistence, it forms the skin, the serous membranes, the vessels, the ligaments, the fasciæ, in short, almost everything excepting the bones, the muscles, the nervous system, and the glands, and they only depart from it in having their particles deposited in its interstices.[1] Meckel even adds to the list the epidermis.

The term mucous tissue was substituted for that of cellular, by Bordeu,[2] owing to its glue-like consistence, and to its resemblance to the corpus mucosum of vegetables. Notwithstanding its propriety on these grounds, yet, as the lining membrane of all the hollow viscera has the same name, some confusion may be produced unless one bears in mind the distinction. Bordeu has expressed the character of the internal cellular membrane very forcibly in saying, that in embryos all their organs are species of buds, which vegetate in the cellular tissue, like plants do in the open air, or their roots in the ground; and that each one having an apartment of its own, this apartment is to it a *cellular atmosphere*, which keeps in a perfect relation with the action of the organ.[3]

In tracing many of the laminæ of the cellular substance, we find, that as life advances, they assume a more fibrous character than what they possessed in infancy; this also occurs when they are pressed upon by tumors, or irritated from any other causes. This disposition of the cellular substance to assume a ligamentous character, in many of the attachments which are formed between the two tissues, frequently leaves it doubtful with which the membrane under examination should be classed; in some individuals the fibrous substance is predominant, and in others the cellular.

In addition to the uses of the cellular substance in forming a nidus for the deposit of all the molecules of the body, and in circumscribing each organ, so as to keep it distinct from the contiguous ones of a different character, its elasticity and yielding nature permit it, in the movements of the several parts upon each other, to change its position, and upon the cessation of the active cause, to re-establish itself. Its extreme flexibility is kept up by a continued exhalation of moisture from the arteries that ramify through its texture. This cellular serosity, when an animal is recently killed, and its internal parts exposed to a

[1] Béclard, Anat. Gén. p. 141. Haller, loc. cit. p. 19; vol. i. p. 113.
[2] Loc. cit.
[3] Loc. cit. p. 65. Recherches Anatomiques sur les Glands, Paris, 1752. Also, an Exposition of the Physiol. and Pathol. Doctrines of Theoph. Borden, understood to be from the pen of a learned friend, R. La Roche, M. D., in the North American Med. and Surg. Journal. Philad. April, 1826.

cold atmosphere, rises in the form of vapor, and has a particular smell. It is more abundant in certain parts than in others; and, as a general rule, where there is the least adipose matter. Indeed, these two substances seem to exist in an inverse ratio: in a person, for example, who has died very fat, the parts are comparatively dry; whereas, in such as have all the adipose matter wasted by a lingering disease, there is a humidity which quickly disposes to putrefaction; a fact frequently exemplified in our dissecting-rooms. The cellular serosity is, consequently, more abundant in the scrotum, in the eyelids, and in the penis. Bichat informs us, that he has satisfied himself, by experiments, of its augmentation during digestion, during heavy perspirations, and after sleep; which will account for the swelling of the eyelids, so commonly observed in the morning, upon rising.

This serosity is albuminous, as proved by its being coagulated by alcohol, and by the mineral acids. It is removed by the absorbents; assisted by the tonic contraction of the cellular membrane, according to M. Béclard.[1] The latter author, indeed, goes on to say, that the cellular membrane is the essential organ of absorption, by which the skin and the villosities of the internal membrane of the hollow viscera perform this function. That the substances introduced through it into the blood-vessels, no doubt, in doing so, undergo some kind of elaboration, in the same way that those do, which are deposited in its interstices for the growth, repair, and changes of the body.

CHAPTER II.

OF THE FAT (ADEPS).

The Adeps, in subjects not much emaciated, is found beneath the skin, between it and the fasciæ, and in the layers of common cellular substance which are next to the muscles: as on the face, the neck, the trunk of the body, the buttocks, the limbs, the palms of the hands, and the soles of the feet. In the adult, it is also found between the serous membranes and the cavities which they line, as in the thorax and abdomen; it is also found between the laminæ of these membranes, as in the omenta, mesentery, and so on. It likewise exists in the interstices between muscles; in the bones, and elsewhere; so that its whole amount is estimated at about one-twentieth of the entire weight of the body. There are, however, certain portions of the body, where its presence would have been very inconvenient: they, accordingly, are destitute of it; to wit, the interior of the cranium, of the ball of the eye, the nose, the ear, the intestinal canal, the eyelids, the scrotum, the penis, the labia interna, and the substance of the glands.

The adeps is of a yellowish color, and of a semi-fluid state in the living body: when after death it has got a few degrees below the stand-

[1] Anat. Gén. p. 149.

ard of animal heat, it becomes somewhat solidified, and then appears in small aggregated masses of different shapes and sizes.

In chemical composition it differs from all other parts of the body by the absence of nitrogen, and is formed of oxygen, hydrogen, and carbon, which render it, in animals, a very suitable article for candles and lamps. According to the analysis of Chevreul,[1] it consists of two kinds of matter, Elain and Stearin; the former of which remains fluid at the freezing point, while, as mentioned, the other becomes solid by a very small abatement of its living temperature. The application of porous paper enables one to separate them in a small way. Strong mechanical pressure does the same thing, and is now much used in the United States, in the manufacture of lard oil for domestic purposes.

The substance called Margarin also exists in most fats, and is the principal constituent of the human; hence the comparative softness of the latter to mutton tallow, where stearin predominates. Stearin liquefies at 148°; Margarin at 118°, and Elain remains fluid at zero of Fahrenheit.

The adeps, though lodged in the cellular substance, is accommodated there under different circumstances from the cellular serosity. This doctrine was first promulgated by Dr. Wm. Hunter,[2] and upon the following grounds: That certain parts of the cellular membrane are destitute of it; that in persons who have died from dropsy, the portions of the cellular membrane which originally contained fat have a more ligamentous condition than others; to wit, those on the loins next to the skin, more than the stratum next to the lumbar fascia; that water or fluids pass readily from a higher to a lower part of the cellular membrane, either when extravasated naturally or injected; that oil, when injected artificially, subsides in the same way, and has a doughy or œdematous feel, yielding readily to pressure and pitting, whereas, fat never shifts its position simply from gravitation.

From these several causes, Dr. Hunter adopted the opinion that the fat of the cellular membrane is lodged in peculiar vesicles, and not, as the water of anasarca, in the reticular interstices of parts. This idea has been generally adopted, and the lobules of fat, when examined with a microscope, are seen to be composed of small grains or vesicles, each one having a pedicle furnished from the adjacent blood-vessel. The parietes of the vesicles are extremely fine, but arranged in the same way with the pulp of oranges, lemons, and such kind of fruit.

The preceding observations on the existence of distinct vesicles for the reception of fat, are sufficiently proved by the microscope.[3] The vesicles are far from uniformity in size. A very common diameter is the $\frac{1}{600}$th of an inch, but they vary from the $\frac{1}{4000}$th to the $\frac{1}{250}$th. These vesicles are composed of organic, independent cells, which have the faculty of eliminating from the blood, the adeps, precisely upon the same principle that the organic cells of a gland, as the liver and mamma, eliminate bile or milk. The fat cells, are sometimes dispersed at wide intervals in the cellular or areolar tissue, but, in other points, they are

[1] Annales de Chimie, vol. xciv.

[2] Medical Observations and Inquiries, London, 1762.

[3] Gerber's Elements of General Anatomy, p. 133, London, 1842.

aggregated in masses, having a common envelop of laminated cellular substance. The interstices of such groups are permeated by blood-vessels, making a minute net-work, for the purpose of furnishing the proper elements to the cells. In particular parts of the body, as upon the soles and palms, but also elsewhere, the cellular substance is traversed by bands and filaments of fibrous matter for the purpose of holding them in place, and also of securing the skin from being torn off or dislodged. The ends of the fingers and toes exhibit striking arrangements of that kind.

Fig. 101.

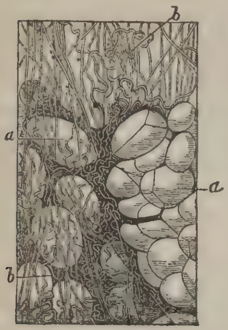


Fig. 102.

Fig. 101. Areolar and Adipose Tissue.—*a*, *a*. Fat cells. *b*, *b*. Filaments of areolar tissue.

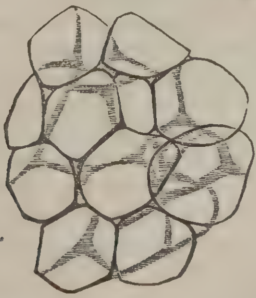
Fig. 102. Capillary net-work surrounding the Fat cells.

Persons who are enormously fat have in the composition of the latter a much higher proportion of Elain, hence, in their dissection the hands of the operator, especially in warm weather, are kept streaming with the oil. This portion of their fat, too, is disposed to gravitate to the lowest point during life, hence the ankles are tumid.

Fat is more abundant in the female than in the male, and in both sexes it is removed as life declines. In the infant the fat is found at the surface of the body chiefly, little or none existing in the interstices of muscles, and in the cavities.

Development.—The fat cell is visible in the human embryo about the

Fig. 103.



Fat Vesicles from the Omentum, magnified about three hundred diameters, and assuming the polyhedral form, from pressure against one another. The capillary vessels are not represented.

fourteenth week of conception. The cells are there insulated, but by the end of the fifth month they are aggregated into groups. They are smaller when first seen than afterwards. In the embryo these cells are furnished with a nucleus attached to the inside of the cell wall and containing one or two nucleoli: it generally disappears afterwards.

Its uses are not fully understood. At some points it serves to diminish pressure, as on the hands and feet: at others it fills up interstices; it is also a bad conductor of caloric, and may, therefore, serve in retaining animal heat. But its most general application is to the purposes of nutrition, it being one of those forms which nutritive matter assumes previously to being perfectly assimilated. This is very fully manifested in hibernating animals, which being fat in the beginning of their torpid state, return from it quite lean; and in insects which, during their repose in the chrysalis form, live upon their own fat while undergoing the metamorphosis into the perfect animal.[1]

[1] Béclard, Anat. Gén. p. 170.

BOOK II.

PART II.

OF THE DERMOID COVERING.

The Dermoid Covering, or Tissue of the body, consists in the Skin; its Sebaceous and Perspiratory organs: the Nails; and the Hair.

CHAPTER I.

OF THE SKIN.

The Skin (Pellis, Cutis, δερμα) is extended over the whole surface of the body, and thereby constitutes a complete investment of it. At the orifices of the several canals which lead into the interior of the body, as the mouth, nose, vagina, anus, and urethra, it does not cease abruptly, but is gradually converted into the mucous membrane of the part, so that it is plainly continuous with it. At certain places, on the middle line of the body, the junction of the skin of the two sides is indicated by a change in its appearance, called Raphe; as on the upper lip; from the navel to the pubes; on the scrotum, and in the perineum; in all of which places, in the development of the fœtus, the two sides of the body are later in uniting than elsewhere.

The color of the skin varies in different nations: it is black in the Negro; of a copper color in the American Indian; bronzed, or tawny, in the Arabian; and white in Europeans and their descendants. It is also subject to various shades, from the mixture of these races, and from the influence of climate; its general tendency being to turn dark on parts exposed to the influence of tropical heat and light.

The external surface of the skin, or that which is free, has on it a great multitude of wrinkles; some of them depend upon the subjacent muscles, as on the forehead and face; some are caused by the flexions of the articulations, and are to be seen at all of these places on the limbs; in addition to which, where there is much emaciation of the parts beneath, the skin not having sufficient elasticity to accommodate itself to their state, is thrown into other wrinkles, and sometimes into loose folds. Finer wrinkles of another description are also found on the skin, arranged in various angular and spiral directions: they

depend on an entirely different cause, which will be treated of elsewhere.

The skin abounds in hairs, which vary in fineness and in length according to the region over which they are distributed: it, likewise, presents many small pits, or follicles, which are the orifices of sebaceous glands. A finer description of pores, which are visible only to the assisted eye, are the ends of the sweat ducts, and there are others which are supposed to be the orifices of exhalants and of absorbents, but this is not so certain.

The internal surface of the skin is connected to subjacent parts by the cellular tissue, which permits a considerable sliding of it backwards and forwards on most parts of the body. On other parts, however, this is restrained, as on the cranium, the palms of the hands, and the soles of the feet, by ligamentous fibres passing to it from the fasciæ and bones below. A very interesting attachment of this kind exists on the fingers, where a plane of ligamentous fibres is seen going from each side of the lower end of the first phalanx, downwards, to be inserted into the skin, half an inch or an inch off; and the bulbous ends of the fingers, thumbs, and toes exhibit also numerous fine ligamentous filaments of the same description, passing amidst the granules of fat from the last phalanges.

Since the first observation of Malpighi, on the tongue of a bullock, whereby he ascertained that its integuments consisted in three layers; and the discovery of a similar arrangement on other portions of the integuments by Ruysch;[1] anatomists have, for the most part, admitted the skin to consist of three laminæ, the Cutis Vera, the Rete Mucosum, and the Cuticula. The latter two, however, have been recently identified, according to the opinion of Albinus at a former period, owing to their common origin as an epidermoid layer.

SECT. I.—OF THE CUTIS VERA.

The *True Skin* (Cutis vera, Derma, Corium) is the deepest, or the layer next to the cellular substance. Its thickness varies according to age, sex, and the region of the body over which it is stretched; on the trunk it is thicker behind than it is in front; on the limbs, thicker on their external than on their internal faces or semi-circumferences. On the mammæ, the penis, scrotum, and external ear, its tenuity is remarkable. When uninjected, it is perfectly white in people of all complexions, and in the living state has a semi-transparency that permits the blood to be seen in the vessels beneath it.

The internal surface of the true skin is so blended with the cellular substance, that in the recent subject there is a difficulty in distinguishing where one terminates and the other begins, yet they may be separated by maceration so as to determine this limit; mortification of the cellular substance sometimes does the same thing; and in the ham, cured by salting and smoking, the true skin, after boiling, may be

[1] Thesaurus Anat. ix.

stripped off with but little difficulty. In either of these cases the internal surface of the latter is seen to be studded with small areolar depressions, caused by the projection of granular masses of adeps; the margins of these alveoli are the principal points of adhesion to the subcutaneous cellular tissue, while their bottoms are pierced with small openings that lead through the skin.

The external surface of the true skin is covered with very fine Papillæ, or villi (*papillæ tactus*), that are readily brought within the observation of the naked eye, by maceration, when protracted long enough to permit the removal of the cuticle. They constitute the Neurothelic apparatus of Breschet. The projections on the tongue are very similar to them, and the whole are designated as the papillary body. These cutaneous papillæ are particularly distinct at the bulbous ends of the fingers and toes, upon the palms and soles, on the lips, on the glans penis, and the nipple; in other parts they are not so evident, but still there should be no doubt of their existence. On the hands and feet they are arranged in double rows or files, which occasion the semicircular and spiral turns of small wrinkles or ridges at the ends of the fingers and toes; and the transverse, oblique, and curved ones, on other parts of the soles and palms. The small, triangular, lozenge-shape, and multangular elevations of the cutis vera, seen elsewhere on its external surface, are caused rather by its contraction than by the papillæ.

These papillary projections resemble very much conoidal, cotton-like filaments, standing up from the twelfth to the third of a line, or thereabouts, from the surface of the skin: they are by no means so long as the villi generally of the intestines, and, like them, consist in very delicate ramifications of nerves and blood-vessels, united by cellular tissue. In places where these papillæ are less abundant, the cutis vera is not so vascular or sensitive. They readily receive a fine injection, and, if the cuticle be afterwards separated by maceration, their vascularity is very distinct, as well as a tufted surface from subordinate projections from them, especially in the feet. Their nerves are destitute of neu-

Fig. 104.

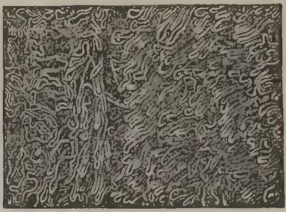
Distribution of the Nerves of the Papillæ at the extremity of the human thumb, as seen in a thin perpendicular section of the skin.

rileme.[1] The nerves and the blood-vessels end in terminal loops. The structure of the papillæ has been especially studied by Pappenheim.

[1] Béclard, Anat. Gén.

The texture of the true skin is filamentous; the fibres which compose it, by their irregular intermixture, resolve it into a sheet of net-work or areolæ, the meshes of which are sufficiently large in some parts to permit the introduction of the head of a small pin. The meshes, though they are larger and more distinct on the internal than on the external

Fig. 105.



Distribution of Capillaries in the papillæ of the skin of the fingers.

surface of the true skin, open, however, upon the latter surface; having passed through the skin obliquely, after the manner of the ureters through the coats of the bladder. Those intervals between the fibres of the skin are rendered very obvious after maceration of a month or two, or after skin has been tanned. They serve to transmit hairs, blood-vessels, nerves, sweat-ducts, absorbents, and exhalant vessels also if such exist. These interstices communicate freely with the cellular substance, for in many cases of anasarca, blisters, when made upon a depending part, empty the cellular membrane of water almost as quickly as scarifications;[1] but if the blisters inflame, they discharge inconsiderably, owing to the interstices being shut up by lymph, and by the tumefaction and fullness of the parts. The same is observable in scarifications.

The tissue which composes the true skin seems to be a mixture of cellular substance and fibrous matter; with a striking predominance of the latter in most parts of the body, though its proportion varies considerably, being more abundant on the thicker parts of the skin, while it is scarcely discernible on the thinnest. The following coincidences of dermoid with ligamentous or desmoid tissue are observable. It becomes yellow and transparent on being boiled, and a continuation of the process dissolves it into gelatin. It resists putrefaction for a long time; is remarkably tenacious. Contrary, however, to white ligamentous matter, it is extensible and elastic, though this property may arise from the oblique intertexture of its fibres; as a bandage from a piece of muslin, when torn longitudinally or transversely, is inelastic, but if it be cut bias, is then very elastic. The application of tannin increases its resistance, and makes it one of the strongest animal substances known in human arts.

The fibrous structure of true skin is principally the white variety, as in common fibrous and areolar tissues, and intermixed with them is the yellow elastic tissue, but in much smaller amount; the proportion of each to the other varies largely in different regions.

The external surface of the true skin is so close that the intervals

[1] W. Hunter, loc. cit.

of its fibres require assistance to the naked eye for satisfactory examination. This surface is supposed from its smoothness to be furnished with a homogeneous basement membrane or membrana propria. Its properties would also lead to such a conclusion, difficult as it is of proof.

The cutis vera is very vascular, and abounds also in nerves and absorbents. The demonstration of the last, on its outer surface, has been accomplished by Tiedemann, Lauth, and Fohman.

The skin has a very strong power of contraction, which is manifested in an amputation, in a long incised wound, or when a sensation of chilliness exists, as in an ague or from the application of cold. Owing to the diminution in size of its areolæ, its external surface then becomes wrinkled, rough, and studded with projecting points, constituting the Cutis Anserina.

SECT. II.—OF THE RETE MUCOSUM.

The Mucous Net, or *Rete Mucosum*,[1] of Malpighi, is the inner surface of the Epidermic layer of the skin, and is that in which resides the color of the several races of men. It covers every part of the surface of the cutis vera; its existence, however, is not so obvious beneath the nails and about the junction of the skin with mucous membranes, as it is elsewhere; though it exists also at these several places, but much finer. It is so extremely thin, and of such a soft mucilaginous consistence, that it is difficult to separate it as a distinct lamina, either by maceration or by any other means; for it most commonly peels off by adhering to the cuticle, after the manner of a pigment. It, however, by good management, may be fairly raised as a membrane, and separated for a certain distance, from the other two coats of the skin.

Fine as this membrane is, it would seem, from the observations of Mr. Cruikshank[2] upon a negro dead from small-pox, and upon a preparation executed in London, by the late Dr. Baynham, of Virginia,[3] and from more recent experiments in Paris, by M. Gaultier,[4] that it consists in several layers. 1. Upon the inequalities or papillæ of the cutis vera, there is a layer called, by M. Gaultier, Bloody Pimples (Bourgeons Sanguins), but which, in the opinion of some other anatomists, are only the papillæ themselves of the cutis vera. 2. Then there is a very thin and transparent coat, called from its color, Tunica Albida Profunda: it is especially visible in the negro, under the colored horns and scales of animals, and beneath the nails of white persons. 3. Over this layer is spread another (the Gemmula), which contains the coloring matter of the several complexions of the human family, and consists in a multitude of dark brown points or granules in the negro; it is visible also in those forms of disease called ephe-

[1] Caldani, Icon. Anat. pl. xci. Albinus, Annot. Acad. Leyden, 1756. Ruysch, Thes. Anat. ix.

[2] Expts. on Perspiration, London, 1795.

[3] Wistar's Anat. vol. i. p. 394.

[4] Recherches sur la Peau, Paris, 1809; in Anat. de l'Homme, par J. Cloquet, pl. cxvii.

lides (freckles), by the French, where the skin becomes spotted; it is not so distinct in the healthy state of the white individual. 4. The last lamina of rete mucosum is called, by M. Gaultier, Tunica Albida Superficialis, from its whiteness and superficial situation; in many animals it is very distinct; in the negro somewhat so, but in the white it is not to be seen except under the nails, about the hair, and under accidental horny excrescences.

These observations of M. Gaultier have been verified by M. Dutrochet,[1] in experiments upon the texture of the skin of vertebrated animals; and were generally acknowledged by the French anatomists. In negroes, in cutting through the skin of the sole of the foot, from heel to toe perpendicularly to the furrows, this arrangement is readily recognized;[2] and when it has become indistinct, it may be improved by immersing the skin for three or four days in lime-water, or a solution of potash or barytes, and afterwards keeping it the same length of time in a solution of corrosive sublimate. Blisters also elucidate this point on other parts of the body: the fluids being locally attracted there, infiltrate the rete mucosum, and separate in part its layers, so as to form a vesicle frequently very thick, particularly in fat persons.

The rete mucosum is very readily affected by the Salt antiseptic mixture,[3] so that it becomes dissolved, and thereby allows the cuticle to loosen from the cutis vera. This fact, repeatedly noticed in the use of the injection and for years, I attributed for a long time to putrefaction, through mistaken views of its real character. I am now satisfied that it is the result of the solvent power of the alkali in this injection: and, as the latter acts so decidedly on the central masses of the nervous system in softening them, probably from the adipose matter contained in them, it is hence not illogical to conclude, that the rete mucosum itself has a large proportion of neurine in its composition, which idea is in harmony with the sensibility of the external surface of the cutis vera. Another cause has been suggested to me by Dr. Leidy, to wit, the alkali acting as a solvent on the new epidermic formation or cells. This injection has a similar softening influence on all mucous membranes, making them almost liquescent.

The scrotum of the negro is well suited to the exhibition of the rete mucosum, as it is there very distinct. It is universally much thicker and better marked in the negro than in any other race. From its extreme tenuity in the whites its existence in them has by some persons been doubted, but erroneously, as in them also its change of color, from the influence of the sun, is readily demonstrated. There are in fact few persons, perhaps none, so white, but what a slight tinge of yellow exists in their skins; which may be proved by contrasting them with any perfectly white surface, as snow, bleached paper, or linen. This slight tinge of yellow is increased to an olive color by the sun's rays, and, in some instances, by a spontaneous deposite; in other cases, it is in certain spots removed, so as to leave a color almost perfectly white, or that only of the cutis vera.[4] When the latter change occurs

[1] Journal de Physique, May, 1819. Journal Complémentaire, vol. v.
[2] J. Cloquet, Anat. de l'Homme, pl. cxvi. fig. 6.
[3] Amer. Journ. of Med. Science, Jan. 1845, p. 245.
[4] A case of this kind is now in the Philadelphia Almshouse, where the absorption of color has occurred in spots on the hands of a dark-complexioned European. June 15, 1826.

in the African, it occasions a hideous piebald complexion, and the cuticle is readily elevated into blisters, by the irritation of the solar rays. Some persons have an entire deficiency of pigment in the rete mucosum, from birth; the same deficiency occurs in the eyes, and hair; they are designated as albinos. The same deficiency of pigment matter on the palms and soles makes in every black person those portions of the skin white. The deficiency of the pigmentum nigrum in the eye causes it to look red, like that of the white rabbit; and also makes it intolerant of a strong light, as that of noonday.

The pigment of the rete mucosum would seem, for the foregoing reasons, to be continually undergoing a deposition and absorption. When it has been lost by a blister in an African, it is generally restored in a short time afterwards: the same occurs in their cicatrices, but requires a longer period. The observations of chemists tend to prove that it is formed principally by carbon. Its apparent use is to defend the skin from the rays of the sun, in illustration of which several ingenious experiments have been executed by Sir Everard Home.[1]

The influence of the continued use of nitrate of silver in giving a leaden color to the skin is well known.

Anatomists generally have rejected the idea of the essential vascularity of the rete mucosum, yet it would seem to have been injected, on one occasion at least, by the late Dr. Baynham, in a leg which was diseased from exostosis;[2] and there are now in the anatomical cabinet of the University three preparations by myself of the fingers of an African, where the coloring matter of the injection has been passed from the papillæ of the cutis vera into the rete mucosum, and there deposited in dots, indicating the former position of the papillæ.

The Rete Mucosum is considered to be a freshly secreted layer, from the cutis vera, which, finally, becomes cuticle by its passing outward and becoming condensed and dried. The observations of Henle go to show that it is constructed of minute oval cells, having each a central nucleus, and as they advance to the surface so as to become cuticle, they change their form into flattened scales.

Messrs. Breschet and Vauzème[3] also limit the number of cutaneous layers to two, the cutis vera, and what they call the corneous tissue or epidermic layers, which mean the rete mucosum and the cuticle of anatomists generally. These two, they say, are a secretion of an apparatus in the thickness of the skin, and which they call blennogenous, from its product, a mucus, which finally inspissates so as to form the rete mucosum and the cuticle. This apparatus, or parenchyma, is furnished with short secretory canals which deposit the mucus between the bases of the papillæ tactus.

There is also, they assert, a glandular apparatus which they call chromatogenous, and furnished with ducts, it being likewise in the thickness of the cutis vera and discharging on its surface. The office

[1] Philos. Transact., London, 1821.

[2] Meckel speaks familiarly of its being furnished with an innumerable quantity of capillary vessels. Vol. i. p. 470.

[3] Nouvelles Recherches sur la Structure de la Peau, par G. H. Breschet et Roussel de Vauzème, Paris, 1835.

of it is to secrete the colored matter of the rete mucosum, hence its name. But its function is also the secretion of the more solid parts of the corneous layer, as the epidermis with its extensions in the form of scales, horns, spines, nails, hoofs, hair, wool, &c.

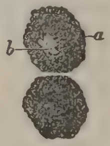
M. Breschet, in addition, alleges the existence of a distinct absorbing apparatus in the rete mucosum, commencing immediately under the superficies of the cuticle and collecting its branches to terminate in the lymphatics of the skin: he does not claim to have seen their mouths.

The state of microscopical anatomy, at the present day, is to identify the rete mucosum with the cuticle, by viewing it as the first development of the cuticle. It is there in the form of nuclei, in various stages of growth into cells, and held together by a tenacious semi-fluid substance. More interiorly, these cells are nearly spherical; farther out they become, by reciprocal pressure, polygonal, and then flattened as they pass on to form the real cuticle.

There are certain elementary changes worthy of notice, marking the distinction of the internal from the external cells. The former contain an opaque, soft, granular matter, and are with their contents soluble in acetic acid; while the latter become transparent, hard, lose their nuclei, are not soluble in acetic acid, and are converted into a sort of horny matter, by a change or deposit of this material within their parietes.

The color of the rete mucosum is constituted by a quantity of what are called Pigment cells, intermixed with the others, and which make the same transition from the cutis vera to the surface. They are seen with difficulty in the white subject, but easily in the colored races: but the choroid coat of the eye in all races exhibits them most freely and beautifully. They each have a nucleus, and present an accumulation within, of numerous rounded or oval granules, measuring each the $\frac{1}{20000}$th of an inch in diameter. What is remarkable about these granules,

Fig. 106.



Pigment Cells, magnified three hundred diameters.—*a*. Cell. *b*. Nucleus.

is, that when examined separately, they are found to be transparent, and not black and opaque—and also exhibit an active movement. This black pigment contains nearly sixty per cent. of Carbon.[1] Light would seem to be the motive for this pigment, which is introduced as a protection to the delicate cutis vera, in the different races of human beings, in a proportion harmonizing closely with their locality on the surface of the earth, and with the delicacy of texture of the cutis vera itself.

If the distinction heretofore admitted, between the Rete Mucosum and the Cuticle, is to be abolished, then, of course, the expositions of Gaultier and of Dutrochet, above recited, are to be qualified also. But,

[1] Carpenter, Elem. of Physiol. p. 147.

at the same time, much difficulty will arise to the practical anatomist in accounting for the succession of distinct laminæ of the rete mucosum, exhibited sometimes by blistering, and in preparations (of which we have some in the Anatomical Museum), where the delimitation of layers is as well marked between the rete mucosum and cuticle, as between a coat sleeve and its lining. The preservation of this distinction need not affect the question of both being derived from the cutis vera in the first instance.

It appears to me evident that the division into rete mucosum and into cuticle, with the admission that the latter is a modified exterior layer of the rete mucosum, is at any rate almost indispensable to clearness in arranging the facts connected with the two: unquestionably there are, at present, many existing anatomical divisions upon lighter grounds.

Another suggestion may also be made, which is, that as the rete mucosum is the basement layer, so its name ought to be retained, and that of cuticle suppressed.

In some very remarkable instances, the skin changes suddenly black. "We have read to the Medical Society of the Faculty the history of a woman whose skin became black in the period of a night, in consequence of a strong moral impression. This woman had seen her daughter throw herself out of the window with her two little children; and we have since had occasion to see, also, a woman, who, having escaped capital punishment, in the revolution, had experienced the same accident. The latter was at the period of menstruation when she learned this news. The menses were immediately suppressed, and from white, which she was, she became as black as a negress, which color continued on to her death. We dissected with care the skin of these two women, and found the colored portion to be the rete mucosum. It was sufficiently easy to isolate the epidermis and the dermis, which presented no abnormal coloration. This black color must be the result of a sanguineous exhalation which operates upon the rete mucosum."

"The violet tinge of the skin is, ordinarily, the result of embarrassed circulation. The skin becomes blue in many very advanced diseases of the heart. The name of Cyanosis, or blue disease, has been given to this color of the skin, which is falsely attributed to an immediate communication of the auricles by means of the unobliterated foramen ovale. This cause of the cyanosis is much more rare than is commonly supposed."[1]

SECT. III.—OF THE CUTICLE (CUTICULA).

The Cuticle or Epidermis, which, as just stated, is a modified free surface to the rete mucosum, is the most superficial portion of the dermoid covering, and takes its wrinkles from the closeness of its application to the true skin. It is a thin, dry pellicle, which cannot be separated from the cutis by dissection; in consequence of which we have to resort to the alternate application of hot and cold water; to

[1] Cours de Médecine Clinique, par Leon Rostan, Paris, 1830.

partial putrefaction; or in the living body to vesicatories. The adhesion between the cuticle and the true skin is through the intervention of the rete mucosum, which being the matrix of the cuticle, and making a uniform adhesion to the cutis vera, establishes of course the same uniformity for the cuticle itself.

In most parts of the body the cuticle or the outer face of the Epidermic layer presents itself of a thickness uniformly about that of the thinnest Chinese blotting paper. Upon the palms and soles of persons generally, but especially of such as are subjected to heavy labor, and exposed to a continued mechanical irritation of these parts, the cuticle becomes much thickened and laminated, obviously from a successive deposit of it on the cutis vera. It is transparent, by which the color of the parts beneath is readily discernible; in the African, however, it is extremely difficult, nay, impossible to clean it wholly of the coloring matter of the rete mucosum.

The structure of this body is as follows: The cuticle consists of several successive layers of compressed cells, originally derived, as stated, from the cutis vera by the intermediate transition into rete mucosum. These cells, finally becoming scales of more and more density as they are nearer the superficies, are continually lost by desquamation and supplied by a new secretion advancing through all the intermediate gradations. Originally of a spheroidal shape, as mentioned above, they become more and more compressed, until they are finally flat planes, or nearly so, with no trace of a central nucleus. The epidermis is absolutely uninterrupted on the surface of the body, so that it is visibly extended even over the cornea, where it presents one of the best examples for the microscope, of the scaly arrangement.

From the epidermis having in itself no power of regeneration, owing to its deficient organization, the most plausible opinion in regard to its source is the above. As the external layer of the rete mucosum, it undergoes there an inspissation, and some modification which render it

Fig. 107.

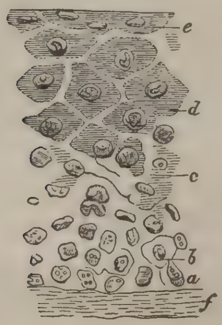


Fig. 108.

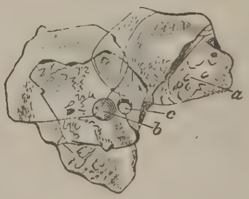


Fig. 109.

Fig. 107. Oblique section of Epidermis, to show the successive development of its component cells. *a*. Nuclei, upon the outer surface of the cutis vera *f*: the nuclei are found to be gradually developed into cells, at *b*, *c*, and *d*: and the cells, being flattened into lamellæ, form the exterior portion of the epidermis at *e*.

Fig. 108. Scales detached from the Epithelium of the Tongue, magnified three hundred diameters. *a*. Scale. *b*. Nucleus. *c*. Globule of fat attached by accident.

Fig 109. Molecules of Pigment, contained in pigment cells, magnified five hundred diameters.

a sort of varnish, well qualified to resist the agency of exterior objects, and to protect the delicate organization of the proximate surface of the cutis vera. This opinion of its origin seems to be adequately proved by its participating in the color of the rete mucosum, more or less, so as to give it a sensible tinge, which cannot be washed from it.

There is no evidence whatever of the existence of vessels in it: on the contrary, in inflammations, when the skin becomes of the deepest tinge of red, the epidermis never has its color changed in the smallest degree; the impression made on it is only manifested by its dropping off, while another layer is preparing to take its place.

A fine injection, when forcibly driven into the extremities of a fœtus, will become extravasated between the cutis vera and cuticle, and raise up the latter in small blisters, as I have frequently experienced, though it cannot be caused to pass through the cuticle.

Neither nerves nor cellular membrane exist in this tissue; it has not the slightest sensibility, neither is this quality evolved by any condition whatever, as it is in tendons, ligaments, and bones, when they become inflamed. The excrescences which belong to it, as corns and indurations, are, like it, laminated, owing to their thickness, and have no interior circulation; and though sometimes painful, are so only by their pressing upon the subjacent nerves of the skin. They are to be viewed as a morbid, or abnormal production of the cutis vera, taking the place of regular cuticle. It is also destitute of filaments.

The cuticle is penetrated by hairs, and by the orifices of the sudoriferous and sebaceous follicles and glands; and according to Bichat, also, by the exhalants and absorbents, the several orifices of which, he says, become distinct by holding it between the eye and a strong light. As it, when raised by a blister, does not allow the effused fluid to pass through any of these pores, it is very reasonably supposed that they are all oblique, and, therefore, exercise a valvular office on such an occasion. Or if, according to the original supposition of Mr. Cruikshank, now sufficiently verified by the microscope, the finest pores of the cutis vera are lined by processes from the cuticle, the collapse of these processes on the separation of the cuticle will also account for the fact. It seems to be well ascertained, at the present time, that as the epidermis is more transparent at certain points than elsewhere, the appearance has been mistaken for porosities of exhalants and absorbents. The cuticle, when detached, will not allow a column of mercury to pass through it, except its weight be so great as to lacerate it: this fact is rather against the doctrine of pores being visible when examined by permitting the light to shine through, and shows that even those for the hairs and the sebaceous follicles are stopped by some arrangement or other.

The cuticle has but little power of extension, and, consequently, of contraction, and tears with the application of a very slight force. It naturally contains so little moisture, that its bulk is only inconsiderably altered by drying. It, like the hair or nails, resists putrefaction so much, that it has been found in burial places after a lapse of fifty years. When held in water, it swells, becomes white, wrinkles more, loses its transparency, and dulls the sensibility of the cutaneous papillæ. It cannot, like the true skin, be readily reduced, by boiling water, into

gelatin, and, consequently, is not affected by tanning: it, indeed, retards that process, when left on the proximate surface of the cutis vera. When applied to a fire, it burns like the hair and nails, with extreme facility, owing to the presence of a similar oil in it, and it gives out a very disagreeable odor.

The little extensibility of the cuticle causes it to be ruptured whenever tumors, as warts, &c., rise from the surface of the cutis vera: it is supposed, however, not to be entirely deprived of this quality, as it seems to stretch when raised into a blister, though this may come, in some measure, from the small wrinkles naturally existing in it being drawn out.

That a loss and reproduction of the cuticle are constantly going on is manifested by the large quantity of branny scales that are detached from its surface, when one has abstained from bathing for a long time. This is more remarkable on the palms and soles than elsewhere, and the loss must of course be continually supplied. It, as is well known, is rapidly regenerated when it has been lost simply by an abrasion or blistering, which has not interfered with the organization of the rete mucosum. In some cases there is an unusual development of it. Bichat retained the skin of a patient, dead at the Hôtel Dieu, in whom the cuticle, at the period of birth and in subsequent life, was three times the natural thickness; and had always, with the exception of that of the face, been subject to a continual desquamation.

One of the most striking properties of the cuticle is its resistance to evaporation from the surface of the body: in a subject, any part of the derm, when deprived of it and exposed to the air, dries up in the course of a day or two; while the other portions remain soft and flexible for weeks, and, if it were not for putrefaction causing the cuticle to peel off, would sometimes remain so for months. Though it suppresses evaporation, in a great measure, it does not do so entirely; for, after a subject has been kept some time, its fingers, toes, nose, and ears get very dry and hard.

The power of the cuticle to absorb or to transmit inwardly articles through it is not by any means so obvious as its exhalation: the facts, however, upon the whole, seem to prove that though this power is much curtailed when compared with that possessed by mucous surfaces, yet it does exist to a certain extent.[1]

CHAPTER II.

OF THE SEBACEOUS, PERSPIRATORY, AND ODORIFEROUS ORGANS OF THE SKIN.

The *Sebaceous Organs* consist in Follicles (*cryptæ mucosæ*) and Glands (*glandulæ sebaceæ*).

The *Sebaceous Follicles*, probably according to the suggestion of M.

[1] Wistar's Anat. vol. ii. p. 396, 3d edit.

Béclard, exist over the whole surface of the skin, with the exception of the palms and soles; because the skin is universally rendered unctuous by a discharge; because many follicles exist, which are only visible to the microscope; and because morbid changes frequently render them evident, where their existence was not suspected before. In many places these follicles are sufficiently obvious and very numerous, as on the nose, about the corners of the mouth, on the ear and behind it, and on the entire face, of some individuals. They consist of small pouches like inflections of the surface of the true skin placed in its thickness, and when it has been injected, are seen to have their parietes abundantly furnished with blood-vessels.

The discharge from them sometimes becomes inspissated, and does not readily pass through their orifices; in which case, continuing to accumulate, it, with the epithelial cells lining them, will, finally, form a sensible tumor. Most frequently it does not collect to such an extent, but is indicated simply by a small black point, owing to the adhesion of dirt to it: in this condition, when squeezed out, it assumes a small vermicular shape.

The sebaceous follicles are said by Mr. Erasmus Wilson to be the residence in great numbers of a curious parasite, the Demodex Folliculorum. The inhabitants of large towns are especially the subjects of this condition.[1]

The *Sebaceous Glands*, properly speaking, are about the size of a millet seed, of a light yellow color, and are placed, wherever they exist, immediately under or near the cutis vera. They are particularly numerous under the skin of the mons veneris. The latter glands may, however, possibly belong to the same order with the miliary glands just under the skin of the axilla, and presently to be noticed.

The sebaceous glands are a more complex arrangement of the simple follicular excavations, and consist of groups of the latter resembling in shape a blackberry, each cell being distinct, but all discharging into a common duct. Sometimes they are laid down in the form of a long tube with side cells or canals entering into it; the Meibomian glands of the eyelids are of this description.

Where the hair is abundant, as on the head, chin, mons veneris, &c., the ducts of the sebaceous glands discharge to a large extent into the sac containing the hair.

The sebaceous organs furnish the oily exhalation, which lubricates the surface of the skin, gives linen, when worn a long time, a greasy appearance, and causes the water in which we bathe to assemble in drops, on the surface of the body, rather than to wet it uniformly. This humor produces a rancid disagreeable smell from the surface of such persons as do not resort to ablutions of the whole skin, from time to time. It is particularly abundant about the places provided with hairs, as the scalp, the genital organs, the axillæ, and seems to be intended to maintain the flexibility and smoothness of the skin and hair,

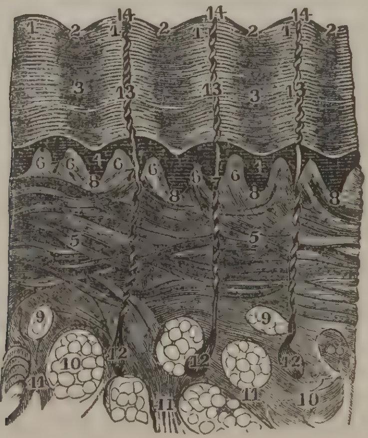
[1] Carpenter's Elements of Physiol. p. 428, Phil. 1846.

and to prevent the former from chapping. These qualities of it are possessed, in a considerable degree, by the oily articles of the toilet, which are used for the same purpose. There can be no doubt of the oily quality of this secretion, as, when collected on a piece of clothing or on blotting-paper, it burns with a white flame. Its quantity is readily augmented by certain kinds of clothing, which most persons must have observed shortly after putting on a flannel shirt next to the skin.

It is sufficiently certain that the apparatus producing this oil is not visible to the naked eye in most parts of the skin, so that there would seem to be some necessity of accounting for its appearance there, either according to the suggestion of Mr. Béclard as above, or in some other way besides that of evident glandular bodies. Bichat considered it to arise from a set of exhalants differing from those which secrete the matter of perspiration, a theory far more rational than that which attributes it to the percolation of the subcutaneous fatty matter.

The Perspiratory Organs.[1]—The perspiration is the product of certain bodies called the Sudoriparous glands, investigated particularly by Gurlt. They are contained in the substance of the cutis vera, but project also into the subcutaneous cellular tissue. These glands are remarkable for consisting of a cylindrical tube generally, which extends itself from the under surface of the true skin to the surface of the cuticle. In the first part the tube is tortuous and collected into a

Fig. 110.



A magnified view of the Sudoriferous Organs of the Skin on the Sole of the Foot.—1, 1. The salient lines of the external surface of the skin cut perpendicularly. 2, 2. The furrows or wrinkles of the same. 3. The epidermis or cuticle, as formed by its superimposed layers. 4, 4. The rete mucosum. 5, 5. The cutis vera, with its cellular fibres pressed into fasciculi and each directed towards the papillæ. 6, 6. The papillæ, each of which answers to the prominences on the external surface of the skin 7. The small furrows between the papillæ. 8. The deeper furrows which are between each couple of the papillæ. 9. Cells filled with fat, and seen between the bands of fibres. 10. The adipose layer, with numerous fat vesicles. 11. Cellular fibres of the adipose tissue, continuous with the subcutaneous cellular tissue, and with that of the cutis vera. 12. The sudoriferous follicles. 13. The spiral or sudoriferous canals. 14. The infundibular-shaped pores or orifices of these canals.

[1] Gerber, p. 143.

spherical ball of about one-sixth of a line in diameter, surrounded by fat vesicles. As the tube then proceeds through the meshes of the corium, or cutis vera, it bends right and left to pass from the deeper to the more superficial layers. Having reached the rete mucosum and the cuticle, it then adopts a spiral direction, the turns being very short, as seen in the filaments attaching the cutis vera and cuticle when they are loosened by maceration. The tube then opens by a conical orifice upon the ridges of the cutis vera made by the papillæ tactus, the ridges at these places being intersected by transverse furrows between the papillæ. The orifice of the sweat duct is lined to some distance by the cuticle, which is sometimes drawn out from it as a short duct or process.

These glands are of a reddish color, semi-transparent, and are found with most ease on the palms of the hands, and on the soles of the feet, according to Gurlt.

The estimate of Krause is, that there are on an average one thousand orifices of sweat glands over every one inch square of the surface of the human body. The largest numbers being on the sole and palm, and amounting to about twenty-seven hundred—and the smallest on the neck, back, and nates, and exceeding somewhat four hundred; on the breast, abdomen, and fore arm there are about 1,100 to the square inch. The entire number he fixes at 2,381,248.[1]

During life the process of perspiration is continually going on, either in a sensible or insensible manner; and according to the experiments of Sanctorius, more than one-half of the weight of our food is lost in that way through the skin and lungs. MM. Lavoisier and Seguin ascertained that the proportionate exhalation from these organs was eleven of the former to two of the latter. When the perspiration is rapid, it assembles on the surface of the body in the form of small drops, having an acid, saltish taste, and a peculiar odor. In this state, according to the analysis of Berzelius, it consists principally in water, holding in solution a hydrochlorate of soda and of potash, some lactic acid, lactate of soda, and a little animal matter. The perspiration, besides its use as an excretion, is a powerful means, by its evaporation, of enabling the body to resist a high temperature. It varies, both in quality and quantity, according to age, sex, state of health, food, and habits of life.

Dr. W. Hunter, though he disbelieved in the possibility of injecting the cuticle, and did not admit the evidence of the preparations of his time having that reputation; yet thought the communicating or perspiratory vessels might be exhibited in a different manner, that is, by macerating for a short time a piece of the sole of the foot: afterwards, in separating the cuticle from the cutis vera, as the two membranes parted, these vessels would be found in the angle of separation passing from one to the other like cobweb filaments.[2]

There can be no doubt of this appearance, for it is easily verified by any one who will take the trouble to perform the experiment. M. Béclard has erroneously suggested, that these filaments are merely the

[1] Müller's Archives, 1844.
[2] Med. Obs. and Inquiries, vol. ii. p. 53, London, 1762.

threads formed out of the rete mucosum, which is rendered a viscous fluid by the commencement of putrefaction; and, therefore, when parted, will put on the same filamentous appearance that half dissolved glue does in a similar situation. Some of the aforesaid filaments also are supposed by Bichat and Chaussier to be absorbents.

The original sentiment of Dr. Wm. Hunter on the perspiratory vessels, being in fact, the delicate filaments between the cuticle and cutis vera, seen on separating them, was reproduced by Gurlt. The arguments against their being the merely softened rete mucosum, as suggested by Mr. Béclard, are their very uniform size, one with another; their spiral line of progress; and their re-appearance at the same spots exactly, which could scarcely be the case, in an inspissated fluid drawn out into strings, and then allowed to collect itself again into a mass, or layer. The process being repeated over and over again with these filaments, will show them constantly returning to the same condition.

The *Odoriferous Glands* (*glandulæ odoriferæ*). I have ventured to give this name to the layer of well marked subcutaneous glands placed in the axilla, and which till lately were too much neglected by anatomists. They are remarkably well evolved and distinct in the negro, though not peculiar to that race, and are just beneath the skin of the arm pit, imbedded in the common adipose cellular membrane, and intermixed with the bulbs of the hairs.

It is well known in our country that the smell of negroes is particularly redolent from the axilla (the same may be said in a qualified way, of persons of all complexions); and that some of them, with the strongest efforts to free themselves from it, are so organized that they may be traced by the effluvium with which they impregnate the air.

Fig. 111.

The layer of glands represented in the accompanying figure will, I think, go largely towards an explanation of that fact, and in doing so,

they may not be improperly called the *Odoriferous Glands* of the *Axilla*. They belonged to an almost coal black male subject, of fine development of skeleton and muscle, not advanced in life, and which was used for the anatomical lectures.[1] The piece is represented as it stands suspended in a round bottle of some sixteen or eighteen ounces, and under a magnifying influence which enlarges the diameters about one-third.

From the representation it will be seen that these glands amount to from two hundred and fifty to three hundred, and make a circular plate about the size of a large Spanish dollar. In raising the skin of the axilla, they are found very near it, and as the skin there is very thin, the principal thickness of the tegument is derived from the subcutaneous cellular layer. These glands are so invested and masked by the layer, that unless a special examination be made for them they are almost certainly overlooked; with the attention, however, directed to them they are found with unerring certainty; and become still more conspicuous by a colored injection and by maceration in water, which infiltrates the cellular substance. They are heaped up near the centre, become more and more scarce towards the circumference, and at the latter have distant intervals between them, some few being so scattered as to form the outposts of the circle.

These glands are of a fuscous color, and vary in size, some being only the half of a line or less in diameter, and others reaching to two lines. The central ones are the larger. They bear upon their surface the granular aspect so common to similar composite glands, as the labial and buccal, the pancreatic and the mammary. Their magnitude is too great to suppose that they are a simple appendage of the hairs of the axilla, which indeed in this subject are few and small: neither do they admit entirely of being placed in the category of perspiratory glands, according to the sentiments of Krause and others.

These glands under microscopic examination are found to have the same structure with the perspiratory glands, presenting in fact a repetition of it, and being therefore generally considered to be the same. The analogy of glandular structure is not, however, always a proof of similar secretions, because the ceruminous glands, for example, resemble the sweat glands, and yet no one pretends that the secretion is identical. Their size, granular appearance and inspissated secretion, with its somewhat peculiar odor, would imply some special action.

The largest sebaceous glands of the skin, as stated by Gerber,[2] considered now excellent authority, are the Meibomian glands as encountered on the eyelids. He also says, with others,[3] that the sebaceous follicles of the skin "generally open laterally into the hair sheaths; they always occur isolated, and are not so universal as the more compound sebaceous glands." In regard to the perspiratory glands of Gurlt, the same authority says,[4] "that their contents being watery and uncolored with pigmentary matter, they are highly transparent, and much more difficult to discover and to examine under the microscope than the sebaceous glands."

[1] December, 1844.
[2] Elem. Gen. Anat. p. 142, London, 1842. [3] Id. p. 327.
[4] Ibid. p. 144.

The necessity, or rather probability of a distinct glandular apparatus, for the peculiar effluvium of the human skin, has been heretofore frequently conjectured. Thus, besides others, we have a recent distinguished authority advancing, that it is probable that by glands of special functions are elaborated the odorous secretions which are exuded from particular parts of the surface, especially the axilla.[1] The same idea is presented in the learned work on Physiology, by Prof. Dunglison,[2] in the declaration that the sebaceous follicular secretions differ materially, according to the part of the body where they exist, as manifested by the varying fluids discharged in the axilla, groins, feet, &c. The real anatomical views of those gentlemen, however, as well as of Müller[3] and of other physiologists, do not seem to go beyond the admission of the ordinary sebaceous cryptæ, and of the sebaceous glands in connection with the hairs.

These glands, though much neglected for some time, were better known at a former period. The celebrated Winslow, Professor of Anatomy in the University of Paris, speaking of the Cutaneous Glands, commonly called Glandulæ Miliares, says, that the under surface of the skin is covered by them, and that they are fixed in fossulæ common to the skin and subcutaneous cellular substance, and that their excretory ducts open on the outer surface of the skin, sometimes on the papillæ, at others on the side of them, as may be seen even without a microscope in the ends of the fingers. The greater part of them, he considers to furnish sweat, and others a fatty oily matter, as on the scalp, on the back, behind the ears and on the nose. He also asserts, that by macerating the skin in water, these miliary glands become more visible, especially in the skin of the lower part of the nose, and in that of the axilla. "The late Mr. Duverney (the master of Winslow) demonstrated to the Royal Academy, that the structure of some of the cutaneous glands resembles the circumvolutions of the small intestines plentifully stored with capillary vessels."[4] These observations may be considered as the precursors of the present state of the glandular Anatomy of the skin, as designated by the microscopical Anatomists, Gurlt, Gerber, Wagner, Todd and Bowman, and still more recently, by Mr. Ch. Rolin,[5] before the French Academy of Sciences, who has also observed them in the groin, where he considers them to be less abundant than in the axilla. But to Duverney, as above, may be safely awarded the credit of elucidating the tortuous line of their ducts, as in the acknowledged course of the sweat glands by Gurlt, and of the ceruminous by Wagner.

[1] Principles of Human Physiology, by W. B. Carpenter, p. 584, London, 1842.
[2] P. 95, vol. i. Philadelphia, 1844.
[3] Physiology, p. 481, London, 1840.
[4] Anat. Expos. of the Struct. of the Human Body, by Winslow, Prof., &c., translated by Douglass, vol. ii. p. 117, London, 1749.
[5] See Am. Journ. Med. Sci. April, 1846, p. 435.

CHAPTER III.

OF THE NAILS.

The Nails (*ungues*) supply the place of cuticle on the extremities of the fingers and toes, and may be considered as a continuation of this membrane, because in maceration they come off along with it. They correspond with the talons and hoofs of the lower orders of animals.

Each nail consists of a root, of a body, and of a free extremity, or that which projects and requires paring. The root is about one-fifth

Fig. 112.

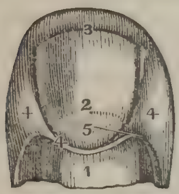


Fig. 113.

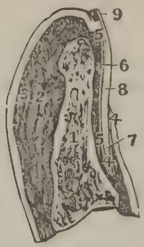


Fig. 112. The Thumb-Nail detached from the thumb and seen on its external surface, with the epidermis of which it is a continuation. 1. Root of the nail deprived of the derma. 2. Its body. 3. Its summit. 4, 4. The epidermis covering the sides of the nail. 5. The crescent or lunula of the nail.

Fig. 113. A Longitudinal Section of the Nail of the Ring Finger. 1. The third phalanx. 2. The adipose tissue. 3. The skin. 4. The root of the nail and fold of the skin in which the root is inserted. 5. The cutis vera covered by the nail. 6. The rete mucosum. 7. Root of the nail. 8. Its body. 9. Its summit or free end.

of the length of the nail; is thin, soft, and white, and is received into a fold or fossa of the true skin, which is very distinct when the cuticle and nail are removed together by maceration. The concave surface of the nail adheres closely to the skin below, precisely as the cuticle does in any other part of the body, and therefore may be loosened by the same processes, as hot water and maceration. The white part of the nail, at its root, is called the Crescent (lunula), and is said, by Mosely,[1] never to exist in the fingers of Africans or of persons who have even a slight mixture of negro blood; the latter opinion I am disposed to consider incorrect. This appearance, however, does not depend upon any peculiar organization of the nail itself at that part, but upon the cutis vera below it, which, being more vascular elsewhere, causes that spot to look white, the nail being semi-diaphanous and permitting a view of the circulation beneath. This is also sufficiently proved by the fact that when a nail is torn off, its lunula disappears. The nail increases gradually in thickness from its root to its free extremity.

[1] Diseases of Warm Climates.

The nail is covered on the posterior face of its root, by the epidermis, which terminates there in a thin, adherent, diaphanous band: behind this band the root of the nail projects, and is received into the groove of the cutis vera. The epidermis also adheres to the lateral margin of the nail, and in a curved line, to the concave side of its anterior end. The under surface of the nail is soft, pulpy, and has an arrangement of superficial longitudinal grooves, receiving the papillæ and ridges of the corresponding surface of the cutis vera. As the black color of the negroes is sometimes seen beneath their nails, it is probable, as stated, that the rete mucosum exists there also; but it is not so clearly ascertained, though the observations of M. Gaultier, on the rete mucosum of animals, tend to prove it.[1]

As the nails are entirely destitute of organization, having neither vessels nor nerves, they have no power of growth nor of disease in themselves, these qualities being derived exclusively from the cutis vera. The materials of their formation are, accordingly, secreted from the cutis vera, in the bottom of the groove, formed by the latter for the reception of their root. As these materials adhere to the preceding formation, and become concrete, by adding continually to its length, they shove it forward, and thereby elongate it. While this is going on in the groove, the thickness of the nail is also somewhat increased by an excretion from the skin contiguous to its concave surface. This accounts for the nail being thicker at its free extremity than at its root.

The skin, where it is in connection with the nail, is called its matrix, and exhibits numerous longitudinal fine ridges which make corresponding furrows into the nail; there are also small papillary projections. The end of the nail at its root is also finely serrated, and the interspaces are filled with corresponding filiform papillæ arising from the skin. These papillæ are the sources of the growth of the nail by the continual secretion from them, and exhibit a close analogy with the arrangement at the roots of the hair. The microscope shows that the original secretion is in the condition of soft nucleated cells, which are attached to their predecessors, and that this arrangement prevails everywhere over the adherent surface of the nail. The fœtal period is the best for observing these nucleated cells. As the growth advances they assume the consistence peculiar to the nail.

Owing to a peculiarly morbid state of the proximate surface of the true skin, it sometimes happens, that the contribution to the nail from it exceeds that from the groove; the consequence of which is, that the whole nail grows upwards like a horn, instead of forwards. An example of this kind was several years ago exhibited to me by Prof. Charles D. Meigs, in a white female, aged about ninety. In this case one of the big toe nails had grown upwards, in a semi-spiral manner, to the length of four and a quarter inches, when measured along the outer edge of the spiral. The corresponding nail of the other side would have been of nearly the same length, but it had been broken. The nails of all the other toes had assumed a similar manner of growth, and measured from one and a half to two inches. In the case of each nail, its anterior extremity presented the primitive nail as it had been before this extraordinary hypertrophy.

[1] See Rete Mucosum.

The statement of the patient was, that the growth had commenced about fifteen years previously. A tendency to this horny growth from the skin was also manifested in a tubercle, three or four lines long, with an ulcerated base, from the back of her nose; and by scaly excrescences on the legs. The patient having died shortly afterwards, the collection of nails was politely presented to the Anatomical Museum by Dr. Meigs.

I am indebted to my friend Dr. Theophilus C. Dunn, of Newport, Rhode Island, a graduate of this University, for a corresponding specimen where the whole foot was preserved, and sent on to me. The case was that of an aged black female, and the nails were the growth of many years, their length being very nearly equal to the preceding; they had, however, kept in a direction forwards, and not vertical as the preceding, and were, therefore, more in the shape of plates.[1]

In cases where the nail has been lost by violence or disease, the cutis vera secretes another; but it differs from the first, unless the cutis vera has been restored to a perfectly healthy action: from this cause, we see in individuals thick black nails, sometimes cleft longitudinally.

The nails begin to appear about the fifth month of fœtal life, and are still imperfect at birth. When analyzed, they seem to consist in coagulated albumen, with a small quantity of the phosphate of lime.

CHAPTER IV.

OF THE HAIRS.

The Hairs (*pili*, *crines*) are cylindrical filaments, which are found on most parts of the skin, excepting the palms and the soles. The finest of them are microscopical, and have not a diameter exceeding the one-sixth hundredth of an inch.

The hairs differ much in their size and appearance in the several parts of the body. Those on the head (capilli, cæsaries) grow to the greatest length of any, and are most numerous in proportion to the space they occupy. Those which surround the mouth, and are on the cheeks (julus, mystax, barba), exceed the others in size, and when allowed to grow, are next in length, and more disposed to curl. Those around the eyes (cilia, and the super-cilia) are not disposed to exceed an inch in length, and have a long slender spindle shape. Those at the orifices of the nostrils and ears are of the same habits as the latter. Those of the arm pit (glandebalæ), and about the organs of generation (pubes), are limited to the growth of a few inches.

In the male subject there are hairs of considerable length on the sternum, and about the nipples, an arrangement which seldom occurs

[1] She had been an inmate of the Almshouse there, and died in the latter part of 1845.

in females. In most individuals, hairs are found over the whole remaining surface of the body; but in females, and in many males, they are too fine to be readily visible. In some subjects, brought into our dissecting-rooms, the pilous system has been so developed as to form a shaggy coat over the whole body, and almost to conceal the skin.

We are informed, on the authority of Jameson's Tour, of a man, at Ava, covered from head to foot with hair. That on the face and ears is shaggy, and about eight inches long; on the breast and shoulders it is from four to five. He is a native of the Shan country, and married a Burmese woman, by whom he has two daughters: the youngest is covered with hair like her father, but the eldest resembles her mother.[1]

In the female the hairs of the head are more abundant, and reach a greater length than they do in the male. As a general rule, the color of the hairs corresponds with that of the eyes and of the skin, and the darker they are, the coarser. According to Withoff, a quarter of an inch square of skin has upon it 147 black hairs, while the same extent has 162 hazel, or 182 white ones, in other individuals.

Each hair consists in a bulb and in a stalk. The bulb is the adherent extremity, and is whiter, softer, and generally larger than any other part; it is received into a follicle, compared appropriately by Malpighi to the vase containing a flower or plant, and which is deposited most commonly in the subcutaneous cellular substance, but sometimes in the skin itself. This follicle is of an oblong ovoidal shape; its open orifice is continuous with the surface of the skin, while its deep end is closed, and has some filaments passing from it to the adjacent cellular substance. It is formed of two membranes; the external is white, strong, and continuous with the derm or cutis vera; the second, being within the last, is more soft, delicate, and vascular, and seems to be a continuation of the rete mucosum, and of the cuticle, if we are to consider, with the microscopists, the two as identical. This layer comes out with the bulb of the hair, on extraction of the latter. From the bottom of the cavity of the follicle, a small conoidal papilla erects itself towards the orifice. In the human subject it is very imperfectly developed, being scarcely visible, but is sufficiently so in the bristles of the upper lip of the larger animals. This papilla is vascular, and from the dissections of M. Béclard, on the human subject, and of M. Rudolphi, on the mustachios of seals, is furnished with nerves. The mode of approach of its vessels is not yet settled. M. Gaultier says that the arteries pass from the surface of the skin into the orifice of the follicle, and then descend, in a serpentine manner, between its two membranes to the bottom.[2] M. Béclard, on the contrary, considers them to pass through the bottom of the follicle. Each piliferous follicle is, moreover, furnished, within its orifice, with many small sebaceous follicles arranged round it.

The bulb of the hair has in it, as seen, a conoidal cavity, open at its base and receiving the conoidal papilla of the follicle. The hair receives its nourishment from the papilla by a successive deposit of nucleated cells just like a nail. The hair is moreover attached to the skin by the cuticle; for the latter, having reached the orifice of the fol-

[1] Littell's Museum, No. 69, p. 412.

[2] J. Cloquet, Anat de l'Homme, pl. cxviii. fig. ii.

Fig. 114.[1] Fig. 115.[2]

Fig. 114. Pulp of a Hair injected, after Hunter. See Catalogue of the Museum of the College of Surgeons, Physiological Series, vol. iii.—1. Cut surface of hair. 2. The pulp 3. Injected vessel ramifying in it.

Fig. 115. Whisker of a Walrus in its follicle, after Hunter. See Catalogue of the Museum of the College of Surgeons.—1. Cut surface of lip. 2. Cutis. 3. External sheath of the follicle. 4. Internal sheath continuous with the cuticle, which, both in the drawing and in the preparations which Mr. Hunter has left, is seen to line the follicle to the point of attachment of the bulb of the hair. 5. Pulp of matrix. 6. Shaft of the hair. 7. Large nerve going to it.

licle, is then reflected for some distance along the hair: this increases the strength of the attachment of the hair to the skin.

The stalk of a hair has generally the loose extremity smaller than any other part, and frequently split. When examined with a microscope, the stalk appears to consist of two substances, one within the other. The exterior is a diaphanous sheath almost colorless, and, from having the properties of the epidermis, may be considered a continuation of it. The microscope shows it to be formed on its outside by minute scales, resembling, but much smaller than those of the epidermis, and arranged into rows like the shingles upon a house, the free edges of which are sometimes transverse, and sometimes oblique or spiral. The stalk of the hair is generally of a cylindrical shape, occasionally it is flattened, but sometimes grooved on one side, so that a transverse section of it resembles in outline a kidney. The interior consists of long filaments, parallel with one another, and occasionally forming a tube in the centre of the fasciculus. These filaments sometimes part spontaneously by the splitting of the envelop, and this may at any rate be accelerated by soaking the hair in dilute acid and crushing it. The filaments of a hair are translucent, and exhibit longitudinal dark streaks intermixed with them, which are produced by collections of pigment or elongated cell-nuclei. The filaments are flat, broad near the middle, and pointed at the end. They measure about

[1] From Muller's Physiol. by Baly. [2] Ibid.

the $\frac{1}{4400}$th of an inch, according to Henle. The tube, as well as the interstices between the filaments, is filled with a fluid called the marrow of the hair, which is defective in the fine hairs over the body, and does not always exist in those of the head. This substance corresponds with one of the layers of the rete mucosum of the skin, and contains the coloring matter. The marrow or medulla appears to be formed of colorless cells, intermingled with the pigment cells. The probability is that the whole hair is a continuation of the rete mucosum, and of the epidermis: whether we are disposed to consider these layers as distinct or identical. The canal in the centre of the hair is found to be remarkably large in the hog's bristle; it is also well seen in the supercilia: the follicle and bulb are best studied in the mustachios of the larger animals. According to Mr. Heusinger,[1] the substance of the hair, when examined with a microscope of strong power, exhibits an areolar appearance.

Though the stalk of the hair is destitute of blood-vessels and of nerves, yet it is probable, from the sudden changes of color that sometimes occur in it from black to white, owing to terror and grief, that there is a species of interstitial circulation going on. The emaciated and peculiar appearance which sickness gives to it would also tend to support this opinion. Strictly speaking, the hairs are devoid of sensibility, yet, as the bulb is planted over a sensitive papilla, they communicate certain sensations by being removed or touched. Animals apply their mustachios particularly to this use, in groping through dark places, or when they are deprived of sight. The hairs are eminently hygroscopic, moisture lengthens, and dryness shortens them; this property has caused them to be applied to the construction of hygrometers.

In certain animals the hairs are erected by the contraction of the subcutaneous muscle. The movement in the human subject corresponding with that is the effect of great fright, and is produced by the contraction of the occipito-frontalis muscle.

In the development of hair, the part which first forms is the follicle, the young hair then pierces it at its summit, in the same way that the tooth pierces its capsule. As the conical papilla or matrix at the bottom of the capsule is the source of hair, the production of the latter is accomplished by a blastema being secreted, in which nucleated cells are developed. The cells there form the flattened filaments and colored streaks of the hair stalk: they also form the imbricated scales on the surface of the hair. The cuticular layer of the follicle is in two laminæ, between which is a fine transparent, fenestrated membrane, discovered by Henle. The death of the capsule, or the drying up of its fluids, occasions the fall of the hair and prevents its regeneration. In old men who are bald, there is no appearance of capsules; while in persons from whom the hair has fallen, owing to sickness, as the capsules still remain, they soon put forth another crop of hair. The rudiments of the hair are seen about the fourth or fifth month of fœtal life. The first crop (*lanugo*) is deciduous, and after covering the body of the fœtus like a fine down, till the eighth month of utero-gestation, it then falls off; sometimes, however, it is retained either in whole or in part till after birth;

[1] J. Cloquet, loc. cit.

this is particularly the case in regard to the hair of the head. In this deciduous character we see an analogy between the hair and the teeth.

When the hair becomes white from age, the conversion of color begins at the loose extremity, another proof of the interstitial circulation, or change of particles in it. The same fact is observable in animals who change color only for the winter. But the restoration of color begins at the root.

It is probable, in those cases of plica polonica attended with bleeding from the root of the hair when it is cut, that the vascular papilla has been so much augmented as to elevate itself above the level of the cuticle, and of course interferes with the sweep of the razor employed in shaving the head. Ignorance in regard to the organization of the hair, and a slight inclination to the marvellous, would magnify this into every hair, in such a disease, being a sort of branch-pipe from the general circulating system, and therefore bleeding upon being wounded. Many of the victims to this disease, accordingly, prefer the loathsome matting of the hair with which it is accompanied to the supposed risk of dying by hemorrhage.

BOOK III.

MUSCLES.

PART I.

MUSCLES AND TENDONS IN GENERAL.

CHAPTER I.

HISTOLOGY OF THE MUSCLES.[1]

THE Muscles (*musculi*) by their contraction produce the various flexions of the body, and are, therefore, the organs of motion. They may be known by their redness, softness, irritability, contractility, and by their being formed of long parallel fibres. The redness, however, does not always attend them; as this color is very faint in the fœtus, and does not exist at all in animals that have not red blood. They form a very considerable share of the whole bulk of the body.

Though the most perfect organs of motion, and producing it more efficiently and rapidly than any other apparatus, they are not indispensable to it; for they are not observable in animals of a very low grade, which apparently consists of a sort of cellular or mucous substance. In the next grade of animals, as the worms, where there is a deficiency both of bony and of cartilaginous skeleton, the muscles are perceptible, and produce locomotion by their attachment to the skin or integuments; and, finally, in animals which have a skeleton, the muscles are almost exclusively attached to its different points, and by alternately approximating them, effect locomotion.

The muscles of the human body are referable to two classes, in consequence of their position and functions, though they present a close similitude of structure everywhere. The most numerous class, as well as that in which they are of the greatest magnitude, are the muscles of voluntary motion, or of Animal life: they are placed be-

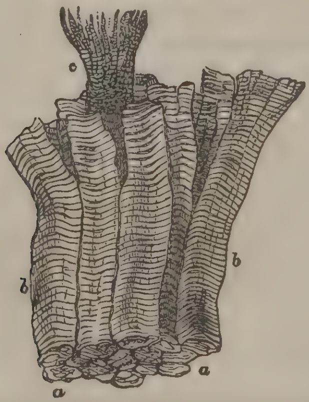
[1] These organs were very imperfectly known to the ancients, excepting Galen, and had not generally received names till the time of Sylvius, A. D. 1587. The paramount authority of Albinus, in this department of Anatomy, in his work, Historia Musculorum Hominis, Leyden, 1734, has induced me to adopt it as the standard of correct description and nomenclature, with but few exceptions.

tween the skeleton and the integuments, and constitute the principal bulk of the extremities, and also afford a thick fleshy covering to the trunk. The second class, being the muscles of Organic life, is contained within the large cavities of the skeleton, and forms a portion of the structure of the circulatory, of the digestive, and of the urinary organs. This set produces the principal internal motions of the animal economy.

Every muscle is surrounded by an envelope of fibro-cellular substance, called its sheath (*membrana musculorum communis*)[1] which at different points of the body exhibits various degrees of condensation. In the muscles of voluntary motion these sheaths are formed by partitions, going from the aponeurotic expansions just beneath the skin, to the periosteum, and are the prolongations which induced Bichat to consider the periosteum as the centre of the desmoid system. These sheaths in some cases preserve to a considerable extent the ligamentous appearance, but generally cellular substance predominates in them. Upon their existence is founded the great variety of views and descriptions which the later anatomists have taken of the fasciæ of the human body, some choosing to describe them in one way and some in another. The sheaths of the second class of muscles are composed of a much finer and looser coat of cellular substance than those of the first, and are commonly described as laminæ or tunics, to the organs to which they respectively belong. In every case, however, from the internal face of the sheaths, a great many partitions pass off, which penetrate the body or thickness of the muscle, and divide and subdivide it into fasciculi, and into fibres, even to their most minute condition. These partitions become thinner, the more they are multiplied.

Many of the muscles are subdivided by fissures into several large portions called Fasciculi, or Lacerti. These vary very much in size, and in their distinctness from each other. Some are so large and so widely separated as to appear like distinct muscles; such, for example,

Fig. 116.



A few Muscular Fibres, being part of a small Fasciculus, highly magnified, showing the transverse Striæ. *a*. End view of *b b*, fibres. *c*. A fibre split into its fibrillæ.

[1] Haller, Element. Physiol. tom. i.

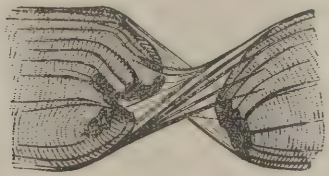
are the biceps of the arm and of the thigh, the deltoid, the columnæ carneæ of the heart, and several others. But the greater part of the fasciculi are strictly parallel with each other, and merely separated by a thin lamina of cellular substance. The fasciculi are again subdivisible into fibres, which from their smallness are scarcely appreciable to the naked eye, and they, when examined with powerful microscopes, admit of farther division until we reach the primitive filaments or fibrillæ. On this account some anatomists have undertaken to classify the fasciculi under the terms of first, second, and third orders. The filamentous arrangement of muscles is rendered still more distinct by boiling them, or by immersing them in alcohol.

The structure of the muscular fibre has been studied with great attention by microscopical observers. From such observations, it appears that their shape is prismatic, pentagonal, hexagonal, sometimes rounded.

SECT. I.—MUSCLES OF ANIMAL LIFE.

The present state of the minute anatomy of the muscles of animal life points out the following conditions. The fibres are arranged with great regularity and in parallel lines, so far as individual fasciculi are concerned. The smallest fibre visible to the naked eye is by the microscope ascertained to be itself a fascis, formed of ultimate subordinate fibrillæ of a cylindrical or polygonal shape, and closely applied to each other. In order to see these ultimate fibrillæ, which admit of no farther division, the best way is to take the smallest distinct fibre, especially of a fish, and pull it apart in its length; its transverse rupture will then show by the microscope a finely divided filamentous end, which filaments, from the incapability of a farther separation, are considered as being the ultimate fibres. This fascis of ultimate fibres is held together by a sheath of its own, called the Myolemma, or Sarcolemma,[1] which is conceived to have a texture different from common cellular substance, and consists of a transparent, very delicate, but strong and elastic membrane, which insulates the fascis from every

Fig. 117.



Fragments of an Elementary Fibre of the Skate, held together by the untorn but twisted sarcolemma.

kind of contiguous structure. The Sarcolemma is amorphous, or has no formal texture generally, but in the case of very large fibres it has

[1] Todd and Bowman, p. 155.

an indistinct evolution of filaments which are interwoven. The sarcolemma of a muscular fascis is occasionally upon the rupture of the latter left entire, which is a good way of studying it, in which case there is some resemblance to a small sword broken in its scabbard; another good way to see it is by maceration, which, by causing the muscular fascis to swell, ruptures the sarcolemma in spots, or elevates it so as to resemble hernia. It is considered to have nothing to do with either the longitudinal or transverse striæ of muscles, and not to be even perforated by the nerves, or by the capillary blood-vessels.

A question still unsettled, is whether one of those smallest muscular fasces is solid, or has a hollow in the midst of its ultimate fibres. The fascis of the human muscle is from about the two-hundredth to the six-hundredth part of an inch in diameter. According to Bowman, the diameter of a fibre or fascis is about the $\frac{1}{400}$th of an inch, being rather more in the male and less in the female. It is larger in reptiles and in fish than in other vertebrata; it is smallest in birds, and what is remarkable, it observes no proportionate size to the species. Thus it is larger in the Chaffinch than in the Owl, in the Cat than in the Horse, in the Frog than in the Boa, and in insects generally larger than in mammalia.[1]

The primitive or ultimate fibrillæ have a diameter, according to Wagner, of from about the 9,000th to the 11,000th part of an inch, and are said by him to be of nearly the same dimensions in all vertebrate animals, in insects and in cray-fish; from five to eight hundred of them compose a fascis of muscle as surrounded by its sarcolemma.

The striped or bead-like muscular fibre is found in all muscles subject to the will, and also in the pharynx, œsophagus, and in the heart. In the œsophagus it is blended with the smooth muscular fibre, or that of organic life, being found at various distances down this tube in different individuals, in some of whom it reaches to within an inch of the stomach.

Such being the present state of microscopical observation on the anatomy of the muscles, it is remarkable how closely the truth was approximated by the earlier descriptions.

Among the first efforts to settle this point are those of Hook, communicated to the Royal Society of London, about the year 1678. Having reduced into filaments the muscles of the cray-fish, he observed that they resembled strings of beads or chaplets, and did not exceed in diameter the hundredth part of a hair.[2] A fasciculus of them, the size of a hair, looked like a necklace, composed of several strings of pearls. Leeuwenhoeck[3] considered the muscles to consist of prismatic bundles of filaments, these bundles being separated by thin membranes, and called by him secondary fasciculi. The filaments themselves formed the primary fibre, and were also separated by very thin membranes; their diameter he estimated at about the two thousandth part of a line. These he called striæ carnosæ, and learned that in insects they made inflections during the repose of the muscle, and which disappeared when it was in an active state. The striæ carnosæ

[1] Carpenter, Princ. of Phys. p. 291.

[2] About the six-hundredth part of an inch.

[3] Opera, t. i. ii. iii.

had to him the appearance of being composed of globules, which he had some difficulty in distinguishing from the inflections or wrinkles. The primary fibre, small as it is, he thought, consisted of a great number of still more delicate fibres, which he called fibræ intimæ.

Prochaska[1] divides also the muscles into three orders of bundles of fibres; the first, second and third, which are respectively kept asunder from their fellows by sheaths of cellular substance penetrating from the general sheath of the muscle. In the third order, or that of the primitive fasciculi, the fibres, he says, are flat, of a thickness somewhat unequal, and run out the entire length of the muscle, even in the sartorius. These fibres are composed of ultimate filaments of a prismatic shape, and whose diameter is about the eighth of a corpuscle of blood, which, estimating at the three-thousandth part of an inch, his measurement corresponds with that of the striæ carnosæ of Leeuwenhoeck. He witnessed also the undulations of the fasciculi and of the fibres, and attributed it to the pressure of filaments of cellular substance, of vessels, and of nerves which traversed their surface.

Fontana[2] gave especial importance to the transverse striæ, which had been seen by others upon the primitive fasciculi, by considering them to be the points of junction of the segments of the primitive fibres, for the latter, he said, were interrupted at equal distances by lines which looked like globules, and might indeed be mistaken for wrinkles. The latter opinion was entertained by Treviranus so late as in 1816.

The transverse striæ are very numerous in the human subject; there are from six to fifteen of them in the hundredth of an inch; their distance then is about from two to five diameters of a globule of blood, fixing the latter at the $\frac{1}{3000}$th of an inch. Bowman puts the distance at the $\frac{1}{9400}$th of an inch.

Fig. 118.

Muscular Fibrillæ of the Pig magnified 720 diameters. *a*. An apparently single fibril, showing the quadrangular outline of the component particles, their dark central part and bright margin, and their lines of junction, crossing the light intervals. *b*. A longitudinal segment of a fibre consisting of a number of fibrils still connected together. The dark cross stripes and light intervals on *b* are obviously occasioned by the dark specks and intervening light spaces respectively corresponding in the different fibrils. *c*. Other smaller collections of fibrillæ.

[1] De carne musculari, 1778.

[2] Treatise on the Poison of the Viper, t. ii.

In meat which is prepared for the table by roasting or boiling, or in a muscle which is contracted, one frequently sees the fibres undulated or crooked. By Prochaska, as just stated, it was attributed to the bridling of the fibre, by the contraction of its cellular substance, nerves, and blood-vessels. The cause, however, is not well ascertained; the condition seems to be one of the peculiarities of muscular fibre, which it manifests when in a state of contraction only; for it disappears whenever the fibre is relaxed, either by spontaneous movement, or by stretching it in the dead body. This undulation has probably contributed to the many inexact observations on the structure of muscles. Thus, Haller thought they consisted in a series of ovoid vesicles, which lengthened in a state of relaxation, and became more globular in a state of contraction. It is unnecessary to dwell on mere errors of the eyes or of the imagination, for the fact seems to be now well established, that, though the muscular fibre, by contracting, loses its straightness and becomes crooked, yet this is effected without change in the form of the ultimate globules of which it consists.

Among the approved accounts of the ultimate structure of muscular fibre, are those of Mr. Bauer, with Sir Everard Home; and of MM. Prevost and Dumas. These gentlemen concur in stating that the results have been uniform in all animals, to which their observations have been extended. That the muscular fibre is a series of globules, resembling the globules of the blood deprived of coloring matter, and adhering in a line to each other. That the medium of adhesion is invisible from its transparency and want of color; but if the muscle be macerated in water frequently changed, that this medium, from its greater solubility and more ready putrefaction, may be removed so as to leave the globules detached from each other, and still resembling the globules of the blood. The fact of the globular condition of the muscular fibre, as stated, was pointed out by Leeuwenhoeck and Hook; it is also approved by the testimony of M. Milne Edwards and M. Dutrochet.

The opinions of the still more recent observers are but slight modifications of the preceding, and it is perceived that the basis of them was evidently laid by Leeuwenhoeck, and by Hook. Many microscopical observers have entered, since 1830, the lists for the purpose of elucidating this structure; an attention to them all would be a history of opinions incompatible with the limits of a class book.[1] Some few may be quoted.

Müller,[2] in admitting the beaded arrangement, says, however, that it is incorrect to consider it as the result of a mere aggregation of globules, because there is a distinct continuation of fibre from one knot to the next. Gerber[3] admits the granular appearance of the primary fibres, but says, that it seems to depend on very short sinuous bendings.

The results of a very protracted and careful investigation of the matter by Dr. Schwann, are, that the diameter of the primitive fasciculus varies from the $\frac{1}{46}$th to $\frac{1}{40}$th of an English line. The primitive fibres of a rabbit, which he asserts to be the most suitable animal for such an inquiry, he says, are bead-like filaments, presenting a series of dark

[1] For information consult Traité d'Anatomie Générale, par J. Henle, p. 152, Paris, 1843.
[2] Physiol. p. 879.
[3] Gen. Anat. p. 240, text.

points; these points being in the bead-like enlargements. He considers the appearance of transverse striæ to be produced by the dark points on the primitive muscular fibre. These points are at uniform distances from one another in the same primitive fasciculus, but may be very different in other and even contiguous fasciculi.[1]

This bead-like state of the muscular fibre is recognized also by Henle,[2] who lays down the rule that all muscles attached to the skeleton have this varicose condition.

Notwithstanding the value and number of the authorities in favor of this knotted state of the primitive muscular fibre in the muscles, at least of animal life, highly reputable testimony is opposed to it. Valentin considers that the primitive fibres, in a state of repose and of health, are straight and homogeneous, but become varicose while in a state of contraction. He says, that thin alternate elevations and depressions on their circumference cause a bead-like appearance, either from its being the result of a special vaginiform condition, or from its being merely the exterior layer of the primitive filament. The central portion of the latter, he concludes, from the result of his microscopic observations, to be uniformly cylindrical.

Treviranus considers the knotted condition of the muscular fibres to be no other than granules, adhering to their exterior surface; such, at least, is the result of his observations upon insects. According to Ficinus, the fresh muscular fibre is straight, and it is upon death that it is resolved into a chain of distinct globules; the latter, indeed, may be simulated by the simple inflections of the muscular fibre.

Krause, after holding the opinion of the bead-like state of the muscular fibre, has more lately[3] retracted the idea under the declaration that this irregularity is due to the commencement of putrefaction, and that it is unusual to see it upon fresh fibres at the beginning of a dissection.

By some it has been asserted that muscles are only the continuation of blood-vessels. To this it is replied,[4] that though insects have muscles, yet they have not blood-vessels, so that the former cannot be a continuation of the latter. Moreover, a successful injection, though it may penetrate very finely between the fibres, so as to cause the muscle to swell considerably, yet none of these vessels can be traced into the ultimate fibre; the blood-vessels thereupon do not penetrate the myolemma, and consequently the ultimate muscular fibre is free from blood-vessels, the latter being only contiguous to it. The vital phenomena and the organization of muscular fibre, are so very different from cellular substance, from nerves, and from vessels, that it cannot be less than a distinct structure.

Notwithstanding this limitation, which is put upon the distribution of the blood-vessels, every muscle is abundantly supplied by them. The arteries come from the adjacent large trunks, and penetrate at different points of the periphery of the muscle. They first of all pass between the larger fasciculi and parallel with them; they then divide and follow the course of the smaller fasciculi; they divide and subdivide again

[1] Müller, Physiol. p. 881.
[2] Anat. Gén. p. 129, t. ii.
[3] Henle, ut supra, p. 158, vol. ii.
[4] Béclard, Anat. Gén.

after the same rule, till they become mere capillary tubes, from which the nutritive matter is exhaled. The veins accompany the arteries, and receive their blood; some of them creep along the surface of the muscle without having corresponding arteries. Bichat says truly, that they are injected with great facility from their trunks, from which he supposes that their valves are less numerous than in other parts of the system.

As the blood-vessels do not penetrate the sarcolemma or proper sheath of a fibre, hence the nutritious fluid is conveyed by imbibition to its final place.

The color of the muscular fibre seems to be, in a measure, independent of the blood which circulates in it. Some animals with red blood

Fig. 119.

Capillary network of Muscle.

have white fibres, as frogs. The color of the muscular fibre is not materially altered in animals that have been suffocated. The muscular fibres of the intestines and of the bladder, though abounding in blood-vessels, are whiter than the muscles of voluntary motion.

Lymphatics have been injected in the intervals between contiguous muscles and between their fasciculi.

The Nerves of the muscles are large and abundant, as the nerves of the brain and spinal marrow are chiefly spent upon them. They are generally proportioned to the size of the muscle which they have to supply, but there is some variety in this respect. They accompany the arteries, and are united to them by cellular substance. Their ultimate terminations are traced with great difficulty, and there is consequently an uncertainty on this subject. Before they disappear, they become soft by divesting themselves of their cellular envelop, and are supposed to bring thus their medullary tubules in immediate contact with the muscular fibre, though like the blood-vessels they do not penetrate the sarcolemma or sheath of muscular fibre. The recent observations of MM. Prevost and Dumas are thought to throw some light on this matter, and have been received with a very respectful attention. They say, that by macerating in clean water, and in a dark place, the muscle of a bullock, and then throwing a strong concentrated light upon it, the distinction of color between the nerves and the muscular fibres becomes very apparent. With the aid of a microscope and a fine knife, the nervous ramifications may be then traced. The trunk of the nerve enters the muscle parallel with its fibres, and soon begins to

give off, at right angles, lateral filaments, which penetrate between the fasciculi and fibres of the muscles, and may be followed to the top of the undulations formed on the muscular fibres. These lateral filaments at some places are two in number, which pass at some distance from each other, but parallel, and terminate by an interchange of filaments; at other places the terminating branches are spread out transversely to the muscular fibre, and end by forming loops with themselves.

Fig. 120.

Loop-like termination of the Nerves in Voluntary Muscle.

According to this view, the nervous filaments, strictly speaking, have no termination, but run again into the source from which they are derived.

The chemical analysis of muscles shows them to be composed of fibrin, albumen, gelatin,[1] extractive matter, the phosphate of soda, ammonia, and of lime, and of the carbonate of lime. The extractive matter of the muscle may be removed by maceration, in clean water often changed. If it be allowed to remain long, it assumes certain appearances in its putrefaction peculiar to itself, but occasionally it is converted into a substance resembling spermaceti. When a muscle is exposed to boiling water, the albumen is raised to the surface, like foam; the gelatin coagulates when the muscle is cold, and the fibrin appears as a fibrous grayish substance, insoluble in hot water, closely resembling the fibrin of the blood, and evolving large quantities of nitrogen by the action of nitric acid. When a muscle is exposed to the fire alone, as in roasting, the albumen is hardened; the gelatin is melted, and runs off, in part, with the juices of the meat; the extractive

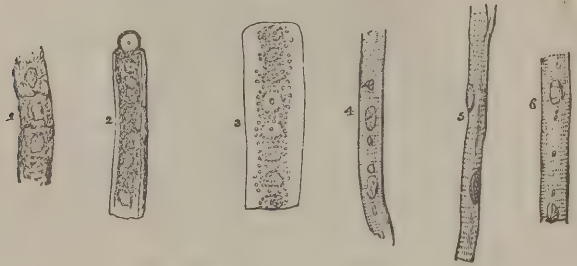
[1] Whether gelatin is to be considered as an ingredient of pure muscular matter appears to be now doubted.

matter is that which gives a dark color to the outside, the fibrin is cooked in the juices of the meat, and is then rendered very tender. The muscular parts of animals are amongst the easiest of digestion.

The muscular system of the embryo is first of all in a gelatinous state, and confounded with cellular substance; but at two months from conception, the fibres are distinct, and at four they begin to contract and to execute different motions.

In the development of muscular fibre, it is ascertained that the Myolemma is first formed, and that by a file of cells placed end to end, which are converted into a tube by the removal of the partitions made by the ends of the cells. The nuclei of the cells are visible for some time after the muscular fibre is formed, but they finally become indistinct as the fibre obtains the matured state, and can only be exhibited by particular management. They are supposed to act as centres of nutrition and reparation, their activity being proportioned to the activity of the muscle itself.

Fig. 121.



Development of Muscular Fibre, after Schwann. 1, 2, 3, are fibres from the dorsal muscles of a fœtal pig, 3½ inches long. 3 represents the fibre (2) after the action of acetic acid. 4, 5, 6 are fibres from the muscles about the humerus of a fœtal pig five inches long. 5 shows the nuclei attached to the wall of the tube; in 4 and 6 is also seen the gradual deposition of the substance from which the fibrillæ are formed on the inner surface of the tubular fibre (magnified about 450 diameters).

The muscular system is subject to varieties of conformation. Robust, muscular individuals frequently have supernumerary muscles and supernumerary heads to their muscles, particularly in the extremities. In monstrous fœtuses it sometimes happens that the muscular system is either wholly or partially supplanted by adipose matter and by infiltrated cellular substance.

SECT. II.—THE MUSCLES OF ORGANIC LIFE.

They have one very plain distinction from those of Animal Life; their fasciculi have frequent anastomoses, and are interlaced in a retiform manner one with another, instead of continuing distinct and in parallel lines. The primitive fibre is, according to Dr. Schwann, about $\frac{1}{1000}$th of an English line, or the $\frac{1}{12000}$th of an inch in diameter. These fibres are also destitute of the transverse striæ, so remarkable in the muscles of animal life. They are almost perfectly smooth, are collected into flattened bands, and are of a light drab color. Here and there, small inequalities or swellings exist, coming from elongated corpuscles, the

nuclei of their formation adhering to them. The fascis formed by the bundle of primitive fibres measures, in its transverse diameter, from the $\frac{1}{2000}$th to the $\frac{1}{3000}$th of an inch,[1] and is, therefore, about the size of a blood-corpuscle, taking the latter number as the unit of measurement. Valentine and Todd do not admit the interlacement of these fibres; the latter considers the appearance as the result of the elongated corpuscles throwing parts of the fibre out of focus, and thus producing a confused reticulated figure. He also doubts that these fibres are invested by a sarcolemma, as he says none has been discovered in an unequivocal manner.

The muscles of organic life are soft, transparent, and, for the most part, deeply seated. The boundaries of their fibres are very faint, and though cylindrical of themselves, yet their fasciculi are flat or prismatic from pressure. The fibres are seldom in lines perfectly straight, but are for the most part bent in a serpentine way, or even crimped like the unravelled yarn of a stocking. The arrangement of the fibres has some resemblance to a fine nervous plexus, and within their meshes are placed mucous glands and other objects. Where the muscular matter is abundant, as in the bladder or the womb, it is arranged into layers, the constituent filaments and fasciculi of which cross respectively at acute or right angles.

The muscles of organic life are supplied with soft grayish nerves, mostly of the motory description, and also with blood-vessels. Their primary filaments are not penetrated by either, but the latter are received into the interstices of their fasces and fasciculi.

It is asserted that the Trichina Spiralis, a small worm not unfrequently found in the muscles of animal life, is seldom or never in those of organic life, so that a definite line is thus established between contiguous parts, as the inferior constrictor muscle of the pharynx and the top of the œsophagus.[2]

CHAPTER II.

ON MUSCULAR MOTION.

The muscles, after death, are soft, easy to tear, and have but little elasticity; it is only during life that they manifest such extraordinary strength, and retain their powers of motion. The general phenomena of the latter have been happily expressed by the word myotility, suggested by M. Chaussier. These phenomena are, contraction, elongation, and, according to Barthez, a power of remaining motionless or fixed.

In contracting, the muscle shortens, swells and becomes hard; presents wrinkles on its surface; and its fibres are sometimes thrown into a state of oscillation or vibration, from their alternate relaxation

[1] Todd and Bowman.
[2] Carpenter's Princ. of Physiol. p. 299.

and contraction. It is owing to the vibratory motion in the fibres of a muscle, during their contraction, that a rustling is heard on the application of the stethoscope to them. The hollow, distant rumbling when the meatus externus is closed by the finger, is owing to the same vibration in the muscles of the finger employed. This is readily proved by the following experiment: close the meatus with the end of the handle of an awl or a fork, pressed against it by the finger, and it will be found that the muscular vibrations are continued along the instrument: plant, afterwards, the point of the instrument upon a soft, inelastic substance, so as to make, in that way, the closure of the meatus, and the rumbling will instantly cease. The roaring noise of sea-shells may be explained in the same way. The color remains the same, which proves that there is not an appreciable addition to the quantity of the circulating fluids. The rapidity with which this contraction may take place is manifested in speaking, in running, and in playing upon a stringed instrument; and its strength by the immense burdens that some individuals can raise and bear.

The capability of the muscles to endure continued action is exhibited daily along the wharves of Philadelphia, through the following statement from an experienced merchant:—A corn carrier between the ages of eighteen and thirty, can convey 21,000 lbs. of corn up a height of thirty-five feet in a day, by the following method. He carries two bushels of 120 lbs. weight up stairs and returns to the wharf in about three minutes. In each day he goes up stairs 175 times and descends as often—mounting in each instance thirty-five steps, and elevating 350 bushels by this process. In addition to this he elevates the bag to his shoulder and again discharges his load—which he usually carries at a run, and traverses some sixty feet of wharf and as much more of store room. This labor is done barefooted, and continued off and on, for a period of about seven years, when exposure and intemperate habits generally kill him and his gang.

The power of elongation or relaxation seems to be an active state of the muscle, as well as its contraction. This power of relaxation or of elongation is much inferior to that of contraction; it seems to be only what is sufficient to restore the muscle to its proper length, so as to put it in a condition for the removal of its contractions. The fixedness of muscles, which are contracted spasmodically, and their retaining this position even after death, until putrefaction begins to assail them, shows that the power of elongation does not depend simply upon elasticity; for the latter quality, being as much the attribute of dead as of living matter, would be brought into play on death.

The fixation of muscles is not a distinct power, but merely a qualification of contraction, by which the latter may be arrested at any given point, and retained there.

As every muscle augments in thickness during its contraction, it has been a subject of inquiry to physiologists whether the whole mass of muscle was increased or diminished by its contraction. Swammerdam, in order to ascertain it, put an insulated solid muscle, not yet dead, into a tube filled with water; by irritating the muscle, and causing it to contract, the water descended; but this result was not uniform. When an arm is plunged into a tube properly formed and filled with water, if the

muscles be caused to contract, the fluid descends; but the objection to the inference from this experiment is, that when all the muscles of the arm are caused to contract violently, the introduction of arterial blood is much arrested, if not fully stopped; and the venous blood is at the same time expelled: so that the change in the size of the member may be accounted for in that way. The experiments of Erman on eels, fully immersed in a fluid, and submitted to galvanic influence, are said to substantiate the theory of the muscles diminishing in bulk by contracting.[1]

The activity of a muscle, though closely depending upon the afflux of blood to it, is not entirely so; for it is ascertained that galvanism will cause the muscles of frogs to contract, when the circulation is arrested by death, or when the blood is coagulated, or even when it has been drawn off.[2] This phenomenon, however, can only last a comparatively short time; for a muscle soon dies, and runs into a state of putrefaction, after its vascular and nervous communications have been cut off. Physiologists have entertained very different opinions on the causes of the muscles contracting, or on muscular irritability, as it is called. Some have supposed it to be an attribute of the muscle itself;[3] others, that it depended on the blood-vessels, which, by bringing a greater afflux of fluids into its interior, between its fasciculi and fibres, obliged the latter two to take a more flexuous course; and others, on the nerves.[4] Any decision on this point is inconclusive, because it is well known that perfect muscular action requires a healthy state of the muscle, and an uninterrupted nervous and sanguineous influence; so that it seems to be a result from the combination of three systems, more than an attribute of one alone.[5]

MM. Dumas and Prevost say, that in consequence of the final nervous ramifications crossing the muscular fibres at right angles to them and parallel with one another, the galvanic current which passes through these ramifications causes the latter to approach each other reciprocally; whereby the muscular fibres to which the ramifications are fixed, are thrown into wrinkles. It is clear, from this theory, that the muscular fibres themselves are destitute of the power of contraction, and that they are only the frame-work upon which the galvanic batteries of the nervous system are displayed.

For a further exposition of these phenomena, and of the opinions on muscular contraction, the reader may consult with advantage the improved modern treatises on Physiology.[6]

There are no muscles which have not the power of contracting some time after apparent death, and this phenomenon frequently continues for an hour;[7] it is uncommon for it to cease with the apparent extinction of life. This irritability is of different durations in the differ-

[1] Béclard, loc. cit.
[2] Prochaska de Carne Musculari, Vienna, 1778.
[3] Haller, Physiol.
[4] Legallois sur le principe de la vie.
[5] Meckel, Anat. Gén.; from Barzellotti, Esame di alcuni moderne teorie interno alla causa prossima della contrazione moscolare, 1796.
[6] See Müller, Dunglison, Carpenter, Todd and Bowman; also Gerber's Gen. Anatomy.
[7] The visitations of Cholera Asiatica in Europe and in this country gave to many persons an opportunity of examining this singular fact.

ent muscles; it is first lost in the left ventricle of the heart; then in the large intestines; afterwards in the small, and in the stomach; then in the bladder, then in the right ventricle, the iris, and in the voluntary muscles; of which those of the trunk die first, those of the inferior extremities next, and those of the superior last. The last act of life is in the auricles, of which the right pulsates longest. Different circumstances may produce some variety of this progress in the loss of muscular irritability, but it will be found generally correct.[1] The experiments of Himly[2] demonstrate, that laurel water, or that of bitter almonds, applied to the stomach or brain, renders the heart insensible to the strongest stimulants, while the muscles of volition continue to move for some hours afterwards. The duration of irritability is, however, much varied, according to the nature of the death, and the state of health preceding. Nysten asserts, that he has seen the right auricle of a robust man pulsate nine hours after death. In death from chronic diseases, with much emaciation, the heart ceases to beat shortly after intellectual phenomena cease. In death from electricity; from a blow upon the stomach; from the inhalation of carburetted hydrogen gas, and some other poisonous ones, muscular contraction also ceases universally in a few moments, and cannot be excited by any artificial means.

The irritability of the muscles is so modified that certain stimulants are peculiarly appropriate to one and not to another. For example, light is the specific stimulant to the iris; a mechanical application to it, as in making an artificial pupil, is borne frequently without its contracting. The heart is very sensible to mechanical stimulants, and additionally so when they are applied to its internal surface.

Some of the muscles are regularly under the influence of the will, others not at all so, which has given rise to their division into the voluntary and involuntary. These states, though kept perfectly distinct from each other in health, are sometimes blended in disease, the voluntary muscles becoming involuntary in their actions, and the involuntary voluntary; which, however, is much more uncommon than the other.

The voluntary muscles being generally such as serve for locomotion and speech, receive their nerves directly from the spinal marrow. The involuntary muscles are such as are concerned in the functions of digestion, respiration, and circulation, and which, in order to continue the life of the animal, must never cease their actions for any long interval. It is worthy of remark, that apoplexy and other cerebral affections paralyze, most commonly, the voluntary muscles alone, while the others retain their usual state and sensibilities.

When irritability is entirely gone from a muscle, and it is actually dead, the whole muscular system becomes stiff, beginning with the trunk, then the inferior, and, lastly, the superior extremities. This stiffness seems to be independent of the nervous system, as the destruction of the spinal marrow, the cutting of nerves, and hemiplegia do not arrest it. It is thought, by M. Béclard, to be analogous to the

[1] Meckel, Anat. Gén.
[2] Commentatio de Morte, Goettingue, 1794.

contraction of the fibrin of the blood; and, like the latter, does not cease till putrefaction begins. The degree, as well as the time, of its access is variable under different circumstances. In very aged persons; in such as have died from protracted disease attended with great emaciation; in scorbutic and gangrenous diseases, the stiffness comes on quickly, is very slight, and disappears in a couple of hours. But in muscular subjects who have died from sudden violence or from acute diseases, the stiffness is sometimes postponed for twelve hours or more, and may continue, in the winter, from three or four days to a week, or even longer, depending upon the access of putrefaction.

The sensibility of the muscles is moderate. When they have been much exercised, they only give out the sensation of fatigue. In amputations, the pain of cutting through them is not equal to that of the skin. In inflammations they, as most other parts, have their sensibility exalted to an exquisite degree.

CHAPTER III.

OF THE MECHANICAL SHAPE AND ARRANGEMENT OF THE VOLUNTARY MUSCLES.

Every muscle consists in a belly and in two extremities, of which the one that is the fixed point is the head or origin, and the other is the tail or insertion. The belly or body is the fleshy part; the extremities are generally tendinous, either completely or partially.

Some of the muscles arise by a single head, and are inserted into one point. Some few arise by a plurality of heads, but have a single insertion, as the biceps flexor of the arm, and of the thigh; others, again, have a single head, but a plural insertion, as the flexors of the fingers and of the toes; others, again, have multiplicate heads and multiplicate insertions, as the muscles of the back.

The most simple muscles are such as have their fibres running in the direction of the length of the muscle, of which there are many examples, as the sartorius, the biceps flexor cubiti, the semi-tendinosus, and others. Others, again, have their fibres running obliquely from a tendon or a bony origin on one side of the muscle, to a tendon on the other, as the semi-membranosus, the peronei, &c.; these are called musculi semi-pennati. Others have a long tendon in the centre, to which the fibres converge obliquely, forming an angle with each other; they are the penniform (musculi pennati). Others, again, are formed of a congeries of small muscles, the fibres of which run in different directions, and are intermixed with tendinous matter, as the deltoid and subscapular. As the strength of a muscle depends upon the number of its fibres, those whose fibres go obliquely are stronger than if their fibres had run longitudinally.

CHAPTER IV.

OF THE TENDONS (TENDINES).

THE tendinous extremities of muscles present themselves under two general shapes: one is funicular, or like cords, varying in shape from cylindrical to paraboloid; the other membranous, and resembling an aponeurosis. They both adhere with great tenacity to the muscular fibres, so as to have induced, erroneously, the opinion of absolute continuity; but maceration and boiling will separate them, and the course of the fibres is different even to the naked eye; besides the very obvious difference in color, in consistence, and in vital properties.

From the observations of Dr. Leidy, it appears that the muscular fibres end in a rounded manner. The filaments of areolar tissue which make the sheaths of muscular fasciculi generally pass in a diagonally crossing manner, around the fasciculi. Sometimes they penetrate between the fibres and intermingle there with some fine filaments of elastic tissue. At the extremities of the muscular fasciculi, the filaments of areolar tissue straighten, and by combining with the fibrous filaments found there, form the tendinous connection of muscle.[1] By this diagonal direction of the investing filaments, extensibility is preserved where wanted, and stability is secured by the straight line at the end of the muscle where it joins the tendon.

The tendons are surrounded by a loose cellular membrane or capsule, which permits them to glide freely upon each other: in some places this membrane is wanting, and is supplied by a synovial membrane answering the same purposes.

The tendons are readily recognized by their white and shining appearance; they have no elasticity or power of elongation and contraction, and, therefore, like most ligamentous matter, they are lacerated sooner than they can be stretched. They are composed of desmoid tissue, the fibres of which are united by a compact cellular substance in small quantities. The fibres are longitudinal, and may be readily separated either by maceration or by a slight boiling. When a round tendon is prepared in this way, it is easy to flatten it out into an aponeurotic membrane: the fibres are then made very distinct, and seem to adhere to each other by lateral fibrillæ. In ordinary health no red blood penetrates into the tendons, but if they become inflamed, as their capillaries then enlarge, they admit the red globules. A minute injection well managed will also penetrate between their fasciculi, and show itself in oblong meshes whose connections cross the fasciculi; as the capillaries, however, have a size superior to that of the ultimate fibrillæ of tendon, the latter are not penetrated by them, but get their nourishment by imbibition. Their sensibility, from being entirely or-

[1] Quain & Sharpey, vol. i. p. 319.

ganic, or what is only sufficient for the internal actions of the organ, is so much augmented in inflammation as to be very manifest.[1] No nerves have been satisfactorily traced into them in the human subject, though Pappenheim declares his success in this matter in the lower orders of animals.[2] The tendons have the character, at large, of the desmoid tissue, but are more gelatinous, or completely soluble in boiling water, than the ligaments. They have a great affinity for the phosphate of lime, and, hence, we frequently find them hardened and having small pieces of bone in them, where they run over bony trochleæ.

[1] A knowledge of the disposition in tendons to augment their powers of circulation on being inflamed, together with the late Dr. Physick's great success in the treatment of false joints by a seton passed through the cavity of the fracture, induced me in a tour of service at the Philadelphia Hospital to try the effect of a similar plan upon a ruptured tendo-Achillis; which, from the long period since the accident had happened, did not promise a cure on the ordinary methods of treatment. A seton of silk riband was accordingly introduced, and kept in its place for six weeks and a-half. It produced considerable pain, tumefaction, and inflammation, but was followed by a perfect reunion of the ruptured ends of the tendon.—See Chapman's Med. and Phys. Journal, for July, 1826. For a highly interesting series of experiments on animals, undertaken at my suggestion, to illustrate the same thing, see An Essay for the degree of Doctor of Medicine, by R. L. Fearn, Id. April 9, 1827.

[2] Müller, Archives, 1843.

BOOK III.

PART II.

SPECIAL ANATOMY OF MUSCLES.[1]

CHAPTER I.

MUSCLES OF THE HEAD AND NECK.

SECT. I.—MUSCLES OF THE FACE.

Occipito-Frontalis.

THE occipito-frontalis, a single muscle, consists of two symmetrical parts, coming from the back of the head, and inserted into the front of it. It is superficial, being placed immediately below the skin of the scalp, and has four bellies of muscular fibres, two behind and two before, connected by a thin tendon (*galea aponeurotica*), which covers all the top of the head. The tendon adheres by a short cellular tissue, having no adeps, to the pericranium below. It is attached to the common integuments above, by an adhesion made by strong fine filaments of fibrous matter, passing in a line, more or less vertical, from the under surface of the skin to the outer surface of the tendon. The common integuments on the hairy scalp are formed by skin and by a closely adhering, and, indeed, almost inseparable layer of granulated adeps, intermixed with the capsules of the hairs, and the fibrous fila-

[1] I may here mention, once for all, in regard to the muscular system, that though the very rigid mode of description adopted by anatomists may lead the inexperienced student to infer that there are no departures from a common standard, and that one invariable type for the muscles prevails in all human beings, yet there will be found upon actual dissection occasional disagreements with the best established descriptions, and which it is of some use to know. Some of these departures are common enough, others very rare; and they consist either in a deficiency or a redundancy of muscles. Wishing not to give false ideas of their importance and frequency, and, indeed, fearful of doing so, they are purposely introduced subordinately in notes: many of them have been observed by me personally, others are recorded in different medical writings, and for the remainder I am indebted to the learned treatises on anatomy of T. Sœmmering and J. F. Meckel.

No part of the muscular system varies more in different subjects than the muscles of the back; but, as it would be useless to enter fully on such trivial details, they have been passed by, except in a few instances.

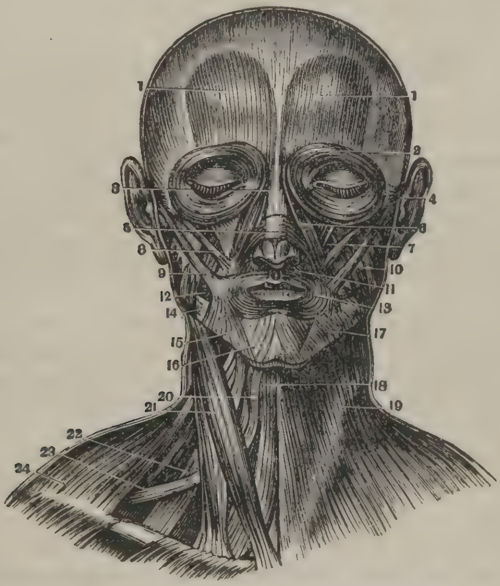
ments alluded to. The thickness of the integuments thus situated is frequently three lines.

This muscle arises from the superior semicircular ridges of the os occipitis by tendinous and fleshy fibres, which form two distinct bellies (*musculus occipitalis*) about an inch and a-half long, one on each side of the bone. Its tendon, when carefully traced, will be found terminating a little in front of the coronal suture, in the two anterior fleshy bellies (*musculus frontalis*) which cover the whole front part of the os frontis. The internal edges of these latter are in conjunction below.

It is inserted, on each side, fleshy, into the superior margin of the orbicularis oculi and of the corrugator supercilii; and, by its nasal slip, into the internal angular process of the os frontis, and into the root of the os nasi.

It pulls the skin of the head backwards and forwards, and throws that of the forehead into horizontal wrinkles. It also elevates the supercilia.[1]

Fig. 122.



A front view of the superficial layer of Muscles on the Face and Neck. 1, 1. Anterior bellies of the occipito-frontalis. 2. Orbicularis or sphincter palpebrarum. 3. Nasal slip of occipito-frontalis. 4. Anterior auriculæ. 5. Compressor naris. 6. Levator labii superioris alæque nasi. 7. Levator anguli oris. 8. Zygomaticus minor. 9. Zygomaticus major. 10. Masseter. 11. Depressor labii superioris alæque nasi. 12. Buccinator. 13. Orbicularis oris. 14. The denuded surface of the inferior maxillary bone. 15. Depressor anguli oris. 16. Depressor labii inferioris. 17. The portion of the platysma-myoides that passes on to the mouth. 18. Sterno-hyoideus. 19. Platysma-myoides. It is wanting on the other side of the figure. 20. Superior belly of the omo-hyoideus near its insertion. 21. Sterno-cleido-mastoideus. 22. Scalenus medius. 23. Inferior belly of omo-hyoid. 24. Cervical edge of the trapezius.

Compressor Naris.

The compressor naris arises by a pointed beginning from the root of the ala nasi, and spreads like a fan over the lateral parts of the nose

[1] Varieties. Its fleshy portion is said to have covered, in some instances, the whole skull-cap.

just above the ala; it is inserted into its fellow of the opposite side along the cartilaginous dorsum of the nose, and into the lower part of the os nasi, being there connected with the nasal slip of the occipito-frontalis.

This muscle consists of thin and pale fibres placed immediately under the skin. If it act from both extremities, by its curved fibres being made straight, it will compress the nostril; but if it act from its dorsal margin, assisted by the nasal slip of the occipito-frontalis, it will dilate the ala nasi, and has, therefore, been called Dilatans Nasi, by Columbus.

The *Dilatans nasi posterior* of Theile is a thin small plane of muscle arising from the upper lateral margin of the anterior bony naris, and the contiguous cartilage of the nose, and is inserted into the ala nasi. It draws the posterior half of the ala nasi backwards and dilates the nasal opening.

Professor Theile informs us that a microscope is required to detect its nature. With such qualifications, its addition to the anatomical description of the face is at least of equivocal utility.

Orbicularis, or Sphincter Palpebrarum.

The orbicularis oculi or palpebrarum is a broad circular muscle, lying immediately under the skin of the eyelids, and over the tarsi cartilages. It is much connected with essential points in the anatomy of the eyelid.

Its diameter exceeds that of the orbit by from four to eight lines all around. The fixed point of this muscle is principally the ligamentum palpebrale internum and the internal canthus of the orbit; for, in the greater part of its extent, besides, it is only loosely attached to the parts below.

The orbicularis arises along the whole superior margin of the internal palpebral ligament. It also arises, by short tendinous fibres, from the upper end of the nasal process of the os maxillare superius, from the internal angular process of the os frontis, and from the contiguous part of the os unguis.

The fibres from this origin compose the lamina of the upper eyelid. They may be traced, thence, around to the lower eyelid, and are found again terminating at the internal canthus of the orbit, where they are fixed into the anterior margin of the orbitar process of the upper maxillary bone, into the lachrymal crista of its nasal process, and into the inferior margin of the internal palpebral ligament from which it arose.

The temporal portion of this muscle is attached to the temporal fascia, so as to prevent it from being much displaced. It is, therefore, obvious that the effect of the contraction of the upper and of the lower half of the muscle will be to bring the eyelids together. The fulcrum of motion is the internal or nasal side, as manifested by the radiated wrinkling of the skin at that point.

The interior portion of this muscle, which is laid upon the tarsi cartilages, is very thin and is called Ciliaris by Albinus: this distinction, which is too arbitrary, is now much disused.

The Corrugator Supercilii.

This muscle is placed beneath the upper margin of the orbicularis, at its internal extremity; by which, and by the adjacent portion of the occipito-frontalis, it is concealed.

It arises from the internal angular process of the os frontis, and going outwards and a little upwards, its fibres are lost in the inferior margin of the occipito-frontalis and in the superior of the orbicularis.

It draws the eyebrow and the skin of the forehead into vertical wrinkles, and also draws them over the eye so as to overshadow it.

The Levator Labii Superioris et Alæ Nasi

Is fixed just at the side of the nose. It arises by a pointed production from the nasal process of the superior maxillary bone at the internal canthus of the eye, and by a broad origin from the anterior margin of the orbitar process of the same bone. Passing downwards, it is inserted into the side of the ala nasi, and into the upper lip, being narrower below than above. The part of this muscle which comes from the orbitar process is so distinct, that Albinus and the continental anatomists of Europe, give it the exclusive name of Levator Labii Superioris.

It draws the upper lip and the ala nasi upwards.

Just beneath this muscle there is sometimes a fasciculus, called the Anomalus Faciei of Albinus, which is attached by one end to the os maxillare superius near the canine fossa, and by the other to the upper lip.

The Levator Anguli Oris

Is a small muscle, concealed very much by the last; it arises from the anterior part of the superior maxillary bone, between the foramen infra-orbitarium and the first bicuspate tooth, and is inserted into the corner of the mouth.

It raises the angle of the mouth.

The Zygomaticus Minor

Is a small muscle, arising from the fore part of the os malæ; it descends obliquely, and is inserted into the upper lip just above the corner of the mouth.[1]

The Zygomaticus Major

Is just on the outside of the last, and is much larger. It arises from the malar bone, externally, at its posterior inferior part, just above the lower edge, where this bone contributes to form the zygoma.

[1] Varieties. Frequently it is deficient; sometimes it is a fasciculus of the orbicularis oculi; sometimes it is double; sometimes it does not reach the corner of the mouth.

It passes obliquely downwards to be inserted into the corner of the mouth, and runs into the depressor anguli oris.

The last two muscles draw the corner of the mouth towards the cheek bone, or obliquely upwards and outwards, as in smiling.

The Depressor Labii Superioris et Alæ Nasi

Is concealed by the orbicularis oris, and the levator labii superioris et alæ nasi. To get a view of it, the upper lip must be inverted, and the lining membrane of the mouth removed on the side of the frænum of the lip. This muscle arises from the inferior part of the upper maxilla in front of the alveolar processes for the dens caninus and the incisores, and is inserted into the side of the ala nasi, and into the contiguous part of the upper lip.

It depresses the upper lip and the ala nasi.

The Depressor Anguli Oris

Arises broad and fleshy from the base of the lower jaw on the side of the chin; being somewhat triangular, its apex is inserted into the corner of the mouth.

This muscle draws the corner of the mouth downwards. It lies immediately under the skin, and blends above with the zygomaticus major and with the levator anguli oris.

The Depressor Labii Inferioris

Is in part beneath the last muscle, and, like it, arises broad and fleshy from the basis of the lower jaw on the side of the chin; its fibres pass obliquely upwards and inwards, and are inserted into the whole side of the lower lip.

It draws the lip downwards.

These last two muscles are much obscured by being mixed with a quantity of adipose matter; the skin, also, is closely blended with them, and the roots of the beard penetrate between the intervals of their fibres.[1]

The Levator Menti, or Labii Inferioris,

Being placed beneath the depressor labii inferioris, is demonstrated by turning downwards the lower lip and dissecting away its lining membrane on the side of the frænum; it will then be seen to arise in front of the alveolar processes of the external incisor and the canine tooth, and, passing obliquely downwards, to be inserted into the lower lip.

It elevates the lower lip.

[1] Varieties. Its exterior border is often formed by the Platysma Myoides.

The Buccinator

Arises from the root of the coronoid process of the lower maxilla; from the tuber or back part of the os maxillare superius near the pterygoid process of the sphenoid bone, and from the roots of the alveolar processes of both the upper and the lower maxillary bone, as far forward as the dentes bicuspides. It is inserted into the corner of the mouth, and into the contiguous parts of the upper and lower lips.

It draws the corner of the mouth directly backwards.

The Orbicularis Oris

Is a circular muscle just beneath the skin, much blended with adipose matter externally, but more plain on the surface contiguous to the lining membrane of the mouth. It constitutes a considerable part of the thickness of the lips, and surrounds the mouth entirely. It has no bony origin, but arises from the fibres of the several muscles which join each other at the corner of the mouth, and therefore consists of two semicircular planes, one for the upper and the other for the lower lip.

It is the antagonist to most of the other muscles of the mouth. From its superior part a pyramidal slip goes to the tip of the nose, being called by Albinus, Nasalis Labii Superioris.

The Masseter.

The masseter is placed between the skin and the ramus of the lower jaw; it is of an oblong shape, and evidently consists of two portions, an external and an internal, which may be readily recognized by the course of their fibres, inasmuch as they decussate.

As a whole, it arises, tendinous and fleshy, from the malar process of the os maxillare superius; from the whole inferior edge of the malar bone, between the maxillary and the zygomatic sutures, and from the zygomatic process of the temporal bone. Of its two portions, the internal is the smaller, and is inserted tendinous into the outer part of the root of the coronoid process of the lower jaw; while the external extends from its origin to the angle and contiguous part of the lower jaw, where it is inserted tendinous and fleshy. A part of the internal portion may be seen at the zygomatic suture, behind the external, without the latter being raised up.

Both portions have the power to close the jaws: the external also draws the lower jaw forward, and the internal draws it backwards.

The Temporalis.

The temporal muscle is placed on the side of the head, and occupies its middle inferior region. It is covered externally by the Fascia Temporalis, a thick, dense, tendinous membrane; which arises by the whole length of the parietal ridge on the side of the cranium, and is inserted into the upper margin of the zygoma, as formed by the malar bone and the zygomatic process of the temporal.

The temporal muscle arises from the inner face of this fascia; from

the whole length of the semicircular ridge on the side of the os frontis and parietale; and from the surface of the cranium between this ridge and the zygoma, including the part contributed by the frontal bone, the parietal, the squamous portion of the temporal, and the sphenoid. This muscle also receives an accession of fleshy fibres from the internal face of the zygoma.

From this extensive origin the fibres converge towards the zygoma, and passing beneath it, are inserted tendinous into the coronoid process of the lower jaw, so as to surround it on every side; some of these tendinous fibres go down in front almost to the last dens molaris.

It pulls the lower jaw directly upwards.

The Pterygoideus Externus.

The external pterygoid muscle, so called from its position, arises fleshy from the outer face of the external pterygoid process of the sphenoid bone, and from the adjoining surfaces of the same bone by its spinous and temporal processes; also from the tuber of the upper maxillary.

It passes outwards and backwards horizontally, and is inserted into the inner side of the neck of the inferior maxilla; into the inter-articular cartilage, and into the capsular ligament of the articulation.

When the muscles of the opposite sides act together, they draw the lower jaw forwards, but if alternately, they give it a grinding motion.[1]

The Pterygoideus Internus.

The internal pterygoid muscle arises by tendinous and fleshy fibres from the internal pterygoid process of the sphenoid bone, along the outer margin of the Eustachian tube, and from the greater part of the pterygoid fossa. Passing downwards and backwards, it is inserted tendinous and fleshy into the internal face of the angle of the lower jaw.

When the muscles of the opposite sides act, they close the jaw.

SECT. II.—MUSCLES OF THE NECK.

Of the Fascia Superficialis Colli.

Between the skin of the neck and its superficial muscles, may be observed a layer of compact cellular substance, the consistence of which is more strongly developed in some subjects than in others. It is the continuation of the same membrane which is spread upon the external abdominal muscles, and is called there the Fascia Superficialis Abdominis. Passing from the abdomen over the thorax, it adheres to the clavicles and sternum, but not very strongly; it then goes from them over the neck to the face, being slightly fastened to the base of the lower jaw, in advance of the masseter muscle.

[1] Varieties. I have seen, in one case, this muscle continued into the inferior margin of the temporal.

It is spread over the submaxillary and parotid glands; is in many subjects strongly marked there by its fibrous character, and sends down partitions between their lobules, as well as between the muscles and their fasciculi, thereby forming sheaths for the same. By these partitions it communicates with the fascia profunda colli. Above it is fixed to the mastoid process; to the meatus auditorius externus, and to the zygoma. Just above the latter it adheres to the fascia temporalis, and a thin layer of fat intervenes between them. This fascia is more strongly characterized about the parotid gland and lower jaw than elsewhere. It is remarkably distinct in the fœtus at full time, the sheaths, which it forms for the muscles, being then very clear of adipose matter, and semi-diaphanous.

The Platysma Myoides,

Or the Musculus Cutaneus, lies upon the fascia superficialis, or rather is included between two laminæ of it, one above and the other below, forming its sheath, which is very thin, especially on the side next to the skin. This muscle covers, by its breadth, a very considerable portion of the side of the neck, and extends, obliquely, from the thorax to the face.

It arises in the condensed cellular membrane on the upper part of the pectoralis major muscle, and of the deltoid, just below the clavicle, nearly the whole length of this bone. Its fibres are much more pale than those of other voluntary muscles; are collected into longitudinal fasciculi, constituting a plane of scarcely a line in thickness, and terminate in the integuments of the lower jaw and of the cheek. It is attached to the lower jaw just in advance of the masseter muscle, and is sometimes inserted for a considerable distance along the base of the same bone. It not unfrequently runs into the muscles of the lower part of the face.

When the whole muscle is in action, it elevates the skin of the neck. The external jugular vein is seen running nearly in the centre of it, in the same direction with the fibres of this muscle, and between it and the sterno-cleido-mastoid.[1]

Upon the upper part of this muscle there is occasionally a thin distinct plane of fibres crossing it and running into the depressor anguli oris. This is the Musculus Risorius of Santorini.

The Sterno-Cleido-Mastoideus

Is beneath, and decussates the last muscle. It forms always a prominent feature in the outline of the neck, in passing obliquely from the upper front part of the thorax to the base of the cranium.

It arises tendinous from the edge of the upper end of the sternum, and tendinous and fleshy from the sternal end of the clavicle. These origins are separated by a considerable fissure; but they soon unite by the clavicular portion, crossing below the sternal.

[1] Varieties. In some rare instances this muscle has been found thick and round; and instead of going towards the face, inserted into the occiput.

It is inserted tendinous into the mastoid process, and into the part of the superior transverse ridge of the cranium next to it.

It draws the chin towards the sternum.[1]

Of the Fascia Profunda Colli.

When the origin of the sterno-cleido-mastoideus is turned to one side, the Fascia Profunda of the neck is seen beneath the fascia superficialis, and somewhat separated from it by a lamina of cellular adipose matter. This membrane arises from the larynx, forms a thin capsule to the thyroid gland, and, being closely attached to its inferior margin, descends by investing the sterno-hyoid and thyroid muscles, being well seen on their anterior surfaces. It is firmly fastened to the upper edge of the sternum, to the sternal end of the clavicles, and to the cartilages of the first pair of ribs, forming an elastic and resisting membrane from the larynx to the thorax. By turning off the sterno-hyoid and thyroid muscles from their attachment to the sternum, the fascia profunda will be seen still more distinctly, passing behind them from the inferior margin of the thyroid gland to the upper bone of the sternum: this lamina of it is inserted into the sternum, twelve or fifteen lines below the upper edge. It encloses or surrounds the transverse vein and the arteria innominata. Beneath the fascia profunda, are the trachea, the roots of the arteries of the head and upper extremities and the trunks of their veins. There is much loose cellular and adipose matter placed at the lower part of the neck, beneath this fascia, and between it and the trachea; through which the thyroid veins with their ramifications pass. This last circumstance must always render suppurations and operations in the part highly dangerous, as the pus will form fistulous passages under the sternum; moreover, the continual motion of the part in respiration prevents adhesions, and, therefore, disposes to ulceration. An ingenious idea on the uses of this fascia, and of the sterno-hyoid and thyroid muscles as connected with it, was suggested by the late Allan Burns: he conceived that they were a defence to the upper part of the thorax, and sustained, in inspiration, the atmospheric pressure, which, without them, would fall upon the trachea and produce difficulty of breathing, from the air not passing through the larynx rapidly enough to keep pace with the dilatation of the thorax. He illustrates the opinion by a case very much in point, of a gentleman who had lost this fascia and the muscles by suppuration, and who was afterwards incommoded by atmospheric pressure upon the trachea at this place.[2] M. Velpeau, on the contrary, asserts that cutting through it in opening abscesses and operations, has no such consequence.[3]

[1] Varieties. Sometimes a fasciculus, at its posterior margin, is presented in a state entirely insulated. Occasionally, its lower extremity has been observed to reach as far as the rectus abdominis muscle, and even to the point of the third bone of the sternum. The fissure between the sternal and clavicular portions in mammiferous animals, is naturally, so much extended as to produce two distinct muscles.

[2] The late Dr. Lawrence informed me that the fascia profunda is well developed in the neck of a cat, and that, having occasion to remove it in an experiment, the respiration of the animal was conducted with great difficulty, amounting almost to suffocation. This is a good confirmation of Mr. Burns's hypothesis. When lymphatic or scirrhous tumors are evolved behind the upper end of the sternum, this fascia forces them against the trachea and thus produces a distressing impediment to respiration.

[3] Anat. Chir. vol. i. p. 438, 2d edit.

The external border of the fascia profunda is continued into the sheath of the great vessels of the neck. It and the fascia superficialis are also continuous with one another along the anterior edge of the sterno-cleido-mastoideus.

Within the inferior maxilla, at its angle, a ligamentous expansion arises at the pterygoideus externus muscle, and is spread out between the styloid process and the ramus of the lower jaw. This membrane, described as the stylo-maxillary ligament, is joined at its inferior edge by the fascia superficialis, just before the upper part of the sterno-mastoideus, and which increases its breadth downwards in the neck, giving it somewhat the condition of a vertical septum of that region: at its lower edge it runs into the sheath of the great vessels of the neck. Through its lower part, penetrate the stylo-hyoideus and the digastricus muscles, and the upper part separates the parotid from the submaxillary gland. It is felt like a cord, extending downwards and backwards below the angle of the maxilla inferior. It is connected at its internal edge with the nerves and vessels of the part, in such a manner as to forbid description; but the practical anatomist will find no difficulty in discovering and understanding it.

Below this septum, a round ligament, (the *stylo-hyoid*,) like a nerve, passes from the extremity of the styloid process to the appendix of the os hyoides. It varies very much in its size, in some being merely a fine thread, which is almost lost below.

The fascia profunda colli is also well marked in the fœtus, and not much blended with adipose matter. It, like the fascia superficialis, is only a sheath for the muscles which it surrounds, and is called fascia from having some development of fibrous matter in its substance.

The Sterno-Hyoideus

Arises thin and fleshy on the interior of the thorax from the approximated surfaces of the cartilage of the first rib, the clavicle, and the first bone of the sternum; it passes upwards somewhat obliquely, and is inserted into the inferior edge of the base of the os hyoides. Its lower end is covered by the sterno-mastoideus.

It draws the os hyoides towards the sternum.[1]

The Sterno-Thyroideus

Is beneath the last, and concealed, in a considerable degree, by it. It arises fleshy from the interior surface of the sternum, about an inch below its upper margin, and from the cartilage of the first rib; diminishing somewhat in breadth, as it ascends, it is inserted obliquely into the side of the thyroid cartilage.

It draws this cartilage towards the sternum.[2]

[1] Varieties. Sometimes it arises from the middle of the clavicle; it is double, or is confounded below with the next muscle.

[2] Varieties. Sometimes there are two of these muscles, one placed above the other; sometimes it runs into the inferior constrictor of the pharynx; sometimes it runs into the posterior margin of the thyro-hyoid muscle; sometimes the muscle on one side is united to the other by transverse fibres. I have, in one instance, Jan. 1, 1830, seen a slip at the external margin of this muscle, which, arising from the cartilage of the first rib, ascended in front of the great vessels, and was inserted into their sheath on a level with the thyroid cartilage

The Thyro or Thyreo-Hyoideus

Arises obliquely from the side of the thyroid cartilage externally, and is inserted into a part of the base, and into the anterior half of the cornu of the os hyoides. It seems almost like a continuation of the Sterno-Thyroideus.

Its use is to approximate the os hyoides and the thyroid cartilage, in doing which it has the effect of planting the epiglottis against the root of the tongue, and of drawing the cricoid and the arytenoid cartilages against it, so that the opening of the glottis is protected.[1]

The Omo-Hyoideus

Passes obliquely across the neck, from the superior edge of the scapula to the os hyoides. It is a thin, narrow muscle, divided into two bellies, one at each end, by an intermediate tendon; its inferior part is concealed by the trapezius muscle; its middle, where the tendon exists, crosses the great vessels of the neck, and is covered by the sterno-cleido-mastoid muscle; and its upper extremity is overlapped by the platysma myoides.

It arises from the scapula just behind the coracoid notch in its superior costa, and curving somewhat downwards in its course, it is inserted into the lower edge of the base of the os hyoides, next to its cornu.

It draws the os hyoides downwards.[2]

The Digastricus

Is placed at the upper side of the neck, and passes from the back part of the base of the head to the chin.

It arises principally fleshy from the fossa of the temporal bone at the base of the mastoid process; its middle is converted into a round tendon, which passes through the stylo-hyoideus muscle, and is fixed by a ligamentous loop or expansion to the cornu of the os hyoides. After which another fleshy belly is formed, which is inserted into the inside of the base of the maxilla inferior, at the side of its symphysis. It receives an accession from the base of the os hyoides.

Its use is to draw the os hyoides upwards when its extremities are fixed, and, as Mr. Hunter has pointed out, to throw the head backwards, and thereby to open the mouth, when the lower jaw is fixed upon a body of the same height.[3]

[1] Varieties. Its fibres sometimes run into those of the middle constrictor of the pharynx; sometimes they arise from the cricoid cartilage; sometimes it is continuous with the sterno-thyroideus.

[2] Varieties. Sometimes it is double, so that besides the usual insertion, it has one into the side of the tongue.

[3] A common variety in this muscle consists in the mutual adhesion of the two anterior bellies belonging to the opposite sides, showing thereby a marked tendency to the quadruped arrangement.

The Stylo-Hyoideus

Is the more superficial of the three styloid muscles. It arises tendinous from the middle and inferior part of the styloid process of the temporal bone; and being perforated, as mentioned by the tendon of the digastricus, is inserted tendinous into the cartilaginous juncture of the base and cornu of the os hyoides.

It draws the os hyoides upwards and backwards.[1]

The Stylo-Glossus

Is within and above the other; it arises from the upper internal part of the styloid process, tendinous and fleshy, and is inserted into the side of the root of the tongue, forming a part of its structure.[2]

It draws the tongue backwards.[3]

The Stylo-Pharyngeus

Is more deeply situated than either of the other two muscles. It arises from the inner side of the styloid process near its root, and runs into the side of the pharynx between the middle and upper constrictors, opposite the tonsil gland; it afterwards descends between the lining membrane of the pharynx and the middle and the lower constrictor, and is inserted into the posterior margin of the thyroid cartilage.

It draws the larynx and pharynx upwards.

The Mylo-Hyoideus

Forms the floor of the mouth and suspends the tongue; it arises at the root of the alveolar processes of the lower jaw, from a ridge extending from the last dens molaris to the chin. Its fibres converge towards a white tendinous line, placed between it and its fellow, and reaching from the base of the os hyoides to the chin, they are in that way inserted into the congeneric fibres of the opposite side. This muscle is concealed by the anterior belly of the digastricus. When it contracts, it draws the os hyoides upwards and projects the tongue.[4]

The Genio-Hyoideus

Is concealed by the last; by turning over the anterior edge of which, it is seen. It arises tendinous from the posterior mental tubercle on the inside of the symphysis of the lower jaw; and, increasing somewhat in breadth, is inserted into the anterior part of the base of the os hyoides.

It draws the os hyoides upwards and forwards.[5]

[1] Varieties. This muscle is frequently double.

[2] See Tongue.

[3] Varieties. J. F. Meckel says that on one occasion he found it double on both sides.

[4] Varieties. Sometimes a part of it is inserted into the middle tendon of the digastricus, or is joined with the sterno-hyoideus.

[5] Varieties. Sometimes a distinct fasciculus of this muscle is inserted into the greater part of the cornu of the os hyoides. Sometimes there is but one muscle. Rarely it is double on both sides.

(For the muscles of the tongue, see *Mouth.*)

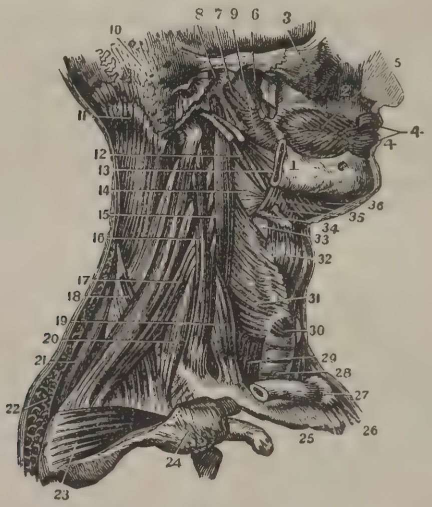
There are several pairs of muscles on the front and sides of the cervical vertebræ which lie closely upon them. They are named from their situations and shapes.

1. *The Longus Colli.*

The longus colli is next to the middle line of the vertebræ. It arises from the sides of the bodies of the three superior vertebræ of the back, and from the anterior edges of the transverse processes of the five lower cervical vertebræ. Its fibres pass somewhat obliquely upwards and inwards, to be inserted into the front of the bodies of all the cervical vertebræ.

It bends the neck forwards, and to one side.[1]

Fig. 123.



A lateral view of the Deep-seated Muscles of the Face and Neck.—1. The inferior maxillary bone. 2. Superior maxillary bone. 3. Malar bone. 4, 4. Orbicularis oris muscle. 5. Buccinator. 6. External pterygoid. 7. Internal pterygoid. 8. Glenoid cavity. 9. Constrictor pharyngis superior. 10. Mastoid portion of the temporal bone. 11. Splenius. 12. Stylo-pharyngeus. 13. Stylo-glossus. 14. Constrictor pharyngis medius. 15. Longus colli. 16. Scalenus medius. 17. Levator scapulæ. 18. Serratus superior posticus. 19. Scalenus anticus. 20. Scalenus posticus. 21. Rhomboideus minor. 22. Cut surface of trapezius. 23. Supra-spinatus. 24. Acromion scapulæ. 25. First rib. 26. Sterno-clavicular articulation. 27. Clavicle. 28. Trachea. 29. Œsophagus. 30. Crico-thyroideus. 31. Constrictor pharyngis inferior. 32. Thyro-hyoid. 33. Thyro-hyoid ligament. 34. Os hyoides. 35. Hyo-glossus. 36. Myo-hyoid.

2. *The Rectus Capitis Anticus Major*

Is placed on the outside of the last. It arises tendinous and fleshy from the fronts of the transverse processes of the third, fourth, fifth, and sixth cervical vertebræ; forms a considerable fleshy belly, and is

[1] Varieties. Sometimes a fasciculus from the first or second rib, or from the body of the sixth or seventh vertebra of the neck, joins it.

inserted into the cuneiform process of the os occipitis, just before the condyle.

It bends the head forwards.[1]

3. *The Rectus Capitis Anticus Minor.*

This is a very small muscle. It arises fleshy from the front of the first cervical vertebra near its transverse process, and is inserted under the rectus major before the root of the condyloid process of the occipital bone.

It bends the head forwards.

4. *The Rectus Capitis Lateralis.*

This is also small, and arises fleshy from the front of the transverse process of the atlas. It is inserted, tendinous and fleshy, at the outside of the condyle of the occipital bone, into the ridge leading from it to the mastoid process.

It pulls the head a little to one side.[2]

5. *The Scalenus Prior, or Anticus.*

The scalenus anticus arises by three distinct tendinous heads from the transverse process of the fourth, fifth, and sixth cervical vertebræ, and is inserted tendinous and fleshy in the upper surface of the first rib, just anteriorly to its middle.

6. *The Scalenus Medius.*

The scalenus medius arises by distinct tendons from the transverse processes of all the cervical vertebræ, and is inserted tendinous and fleshy into the upper face of the first rib, in all the space from its middle to its tubercle.

7. *The Scalenus Posticus.*

The scalenus posticus arises from the transverse process of the fifth and sixth cervical vertebræ, and is inserted into the upper face of the second rib, just beyond its tubercle.

The last three muscles are concealed by the sterno-cleido-mastoideus and the anterior edge of the trapezius. The scalenus posticus is best seen in dissecting the muscles of the spine, and resembles very much one of the class to which Albinus gives the name of Levatores Costarum.

All the Scaleni elevate the ribs and bend the neck to one side. They are particularly interesting as connected with the course of the large blood-vessels and nerves of the upper extremity.[3]

[1] Sometimes it also arises from the first and second vertebræ.

[2] Varieties. Sometimes another muscle arises from the body of the first vertebra of the neck.

[3] Varieties. Besides the three scaleni which are described, there are frequently supernumerary muscles or fasciculi. One of these, called the Scalenus Minimus Albini, is between

CHAPTER II.

MUSCLES OF THE TRUNK.

SECT. I.—MUSCLES ON THE FRONT OF THE THORAX.

The Pectoralis Major

Is superficial, and forms the large swelling cushion of flesh under the skin of the breast. It arises tendinous and fleshy from the anterior face of the first two bones of the sternum, their whole length; fleshy from the cartilage of the fifth and the sixth ribs, and by a fleshy slip from the upper part of the tendon of the external oblique muscle. It arises, also, fleshy from the sternal two-thirds of the clavicle. The clavicular and sternal portions of the origin are separated by an interval, giving the appearance of two muscles.

The fibres converge, and terminate by a broad, thin tendon, which is inserted into a roughness on the exterior edge of the bicipital fossa of the os humeri, and into the fascia brachialis, just at the internal edge of the deltoid muscle. At this insertion it adheres to the tendon of the latissimus dorsi. The under edge of the muscle, near its insertion, is folded inwards and upwards, which gives the rounded thick margin to the fore part of the axilla. That part of the broad tendon belonging to the clavicular portion is inserted lower down than the sternal, which produces a decussation of the fibres of the tendon.

The pectoralis major draws the arm inwards and forwards; and also depresses it when it is raised.[1]

The Pectoralis Minor

Is brought into view by raising the last muscle. It is comparatively small, and somewhat triangular. Arising by thin tendinous digitations

the first two, and occasionally appears as a fasciculus of the scalenus anticus, separated from it by one or more of the brachial nerves; it is sometimes double. Another fasciculus, called the Scalenus Lateralis, is between the scalenus medius and posticus; it comes from the transverse process of the fourth, fifth, and sixth vertebræ, and is inserted into the posterior part of the first rib.

[1] Varieties. Sometimes a single fasciculus arises from the eighth rib, which ascends towards the os humeri, has a tendon in its centre, and finally joins with the tendon of the pectoralis minor;—sometimes this muscle detaches a small fasciculus to the brachialis internus;—sometimes there is a small square plane of muscular fibres on its front surface, decussating the fibres at right angles;—sometimes a fasciculus almost cylindrical proceeds from it towards the axilla, and, being changed into a long tendon, is inserted into the internal tuberosity of the os humeri. Supernumerary fasciculi are also found going from one rib to another, or towards the sternum; sometimes its tendon detaches a fasciculus, which, crossing the insertion of the muscle, covers the bicipital groove of the os humeri like a bridge, is blended with the tendon of the supra-spinatus, and increases the thickness of the capsular ligament of the shoulder joint. In a muscular male black subject, it was entirely deficient, except the external clavicular half. The pectoralis minor was wholly wanting in the same. Decr. 1837.

from the upper edge of the third, fourth, and fifth ribs, it soon becomes fleshy, and is inserted, by a short flat tendon, into the inner facet of the coracoid process of the scapula.

Its use is to draw the scapula inwards and downwards.[1]

The Subclavius

Is a small muscle, placed immediately under the clavicle. It arises from the cartilage of the first rib, and is inserted into the inferior face of the clavicle, from near the sternum, to the conoid ligament, which connects the coracoid process and the clavicle together.

It draws the clavicle downwards.[2]

The Serratus Magnus, or Serratus Major Anticus,

Is a broad muscle, lying on the sides of the ribs, between them and the scapula, and beginning at a line anterior to their middle. It arises from the nine upper ribs by fleshy digitations, the superior one of which seems almost like a distinct muscle ; the five lower are connected to the obliquus externus abdominis, the digitations of the two muscles interlocking with each other. The fibres converge, and are inserted into the base of the scapula its whole length.

Its action is to draw the scapula forwards.[3]

The Intercostales

Fill up the spaces between the ribs, and have much tendinous matter running in the interstices of their fibres and in the same line with them. There are two in each space, of which the External arises from the transverse process of the vertebra, and from the inferior acute edge of the rib above, from its head almost to its cartilage, and is inserted into the superior rounded edge of the rib below for the same distance, its fibres passing obliquely forwards and downwards. The Internal intercostal arises from the inferior edge of the rib and the costal cartilage above, beginning at the sternum, and extends backwards to the angle of the rib ; it is inserted into the superior rounded edge of the rib and costal cartilage, below, on its inner side, its fibres passing obliquely backwards and downwards.

They draw the ribs together.

[1] Varieties. Sometimes it sends a fleshy fasciculus to the tendinous origin of the coraco-brachialis. Sometimes, below it, there is a third pectoral muscle, which arises from the first and second rib, and is inserted into the coracoid process ; whereby a striking analogy with birds is established. Another variety has also been observed in the existence of a fasciculus, which comes from the upper rib, and which, covered by the little pectoral muscle, is inserted into the capsular ligament of the scapulo-humeral articulation.

[2] Varieties. Sometimes two muscles exist; a bursa mucosa is formed between its tendon and the cartilage of the first rib.

[3] Varieties. Sometimes, it has ten or eleven origins; the upper origin is deficient ; the latter is so distinct that it may pass for a particular muscle; a wide gap exists in the middle of the muscle, dividing it into two distinct parts.

The Triangularis Sterni

Is on the posterior or cardiac face of the cartilages of the ribs, and arises from the whole length of the cartilago ensiformis at its edge, and from the inferior half of the edge of the second bone of the sternum. The fibres go obliquely upwards and outwards, to be inserted into the cartilage of the third, fourth, fifth and sixth ribs by fleshy and tendinous digitations.

Its use is to depress the ribs, and, consequently, to diminish the cavity of the thorax.

This muscle is frequently defective or redundant in the number of its heads, and is commonly more or less continuous with the transversalis abdominis; but occasionally it is so much so that the two seem to make but one muscle, and have, therefore, been called Sterno-abdominalis, by Rosenmuller.

SECT. II.—MUSCLES AND FASCIÆ OF THE ABDOMEN.

Between the most superficial of the abdominal muscles, which is the external oblique, and the skin with the subcutaneous fat, is found the Fascia Superficialis Abdominis. In lean subjects it is very distinct, but in fat ones not so much so, from being blended with adipose matter. The laminæ of it which are next to the muscles, are kept, in the latter case, rather more free from fat than the more superficial. It consists of condensed cellular substance, with very little fibrous matter in it, and may be considered as taking its origin on the front of the thigh, and extending in front of the abdominal muscles, as high up as the thorax: indeed, if we are disposed to trace it in its whole extent, there is no difficulty in following it over the front of the thorax; thence to the neck, as the fascia superficialis colli; and even to the face.[1] In ordinary cases its desmoid or aponeurotic character is very equivocal, but where the parts about the groin have been pressed upon and thickened by the irritation of hernial protrusion, it is better marked. On the thigh it is blended with fat; and encloses between its laminæ the lymphatic glands of the groin, and the external pudic vessels given off from the femoral artery, immediately below Poupart's ligament. On the tendon of the external oblique it is more condensed; branches of the femoral artery are also seen in it there. One longer and larger than the others, the Arteria ad cutem abdominis of Haller, winds over Poupart's ligament, and runs upwards somewhat in the line of the epigastric artery, to be distributed to the skin of the abdomen: the

[1] This statement of origin is to be viewed merely as an anatomical license for descriptive purposes; the most natural line of origin is the whole length of the linea alba, and this same line might be considered as going along the front of the sternum for the pectoral fascia, and along the middle of the neck for its fascia superficialis and profunda. There is one practical advantage in raising this fascia from the side towards the linea alba, that we see better a linear close adhesion which it makes with the edge of Poupart's ligament, and also how the part near the anterior superior spinous process, not forming such an adhesion, goes down to the thigh and spreads itself over the whole front of the inguinal portion of the femoral fascia. This mode of raising exhibits also, more satisfactorily, the close adhesion of this fascia to the linea alba behind and to the same line of the skin before.

division of it will produce sufficient hemorrhage to require attention. On the symphysis pubis and about the external ring the laminæ of the fascia superficialis are multiplied, and it has more of the character of common adipose matter, as in most cases the adeps there is abundant and forms in both sexes, the protuberance called the Mons Veneris, or *Penil.* From the pubes it may be traced as a condensed cellular membrane, blended with the ligamentum suspensorium, along the penis to its extremity; and, according to Mr. Colles, of Dublin, matter formed beneath it there, is apt to create fistulous sores on this organ. A thin process of this membrane, the Spermatic or Inter-columnar fascia, adhering to the circumference of the external abdominal ring, may be traced along the spermatic cord, and identified with the tunica vaginalis communis. The fascia abdominalis is more loosely connected to the parts beneath it on the thigh, near the anterior margin of Poupart's ligament, than elsewhere, which disposes femoral hernia to observe that course in its increase. Along the margin itself of Poupart's ligament, it forms a close adhesion.

The Fascia Superficialis, under the name of Tunica Abdominalis, is well developed in animals with a large and projecting belly, particularly in the large ruminantia and the solipedia. It has a yellowish tinge in them, is very elastic and strong, and well calculated to support their viscera.[1]

There are five pairs of muscles called abdominal; to wit, the External Oblique; the Internal Oblique; the Transverse; the Straight; and the Pyramidal. The first three are flat and broad, and lie in layers one upon the other; the other two are long.

1. *The Obliquus Externus.*

The external oblique arises from the eight inferior ribs by muscular and tendinous digitations attached near their anterior extremities. The first head is covered by a slip from the pectoralis major, the five upper heads are interlocked with the origins of the serratus major anticus, and the three inferior with those of the latissimus dorsi. The fibres pass obliquely downwards, and terminate in a broad thin tendon. This tendon extends over the whole front of the abdomen, from the lower end of the second bone of the sternum to the symphysis of the pubes.

This muscle is inserted or fixed into the whole length of the linea alba; into the anterior half or two-thirds of the crista of the ilium, by muscular fibres posteriorly, and tendinous anteriorly; and, from the anterior superior spinous process, the tendon extends to the body and to the symphysis of the pubes, forming thereby the ligament of Poupart, or the Crural Arch.

In the middle line of the body, the tendons of the three broad muscles, on both sides of the abdomen, unite to form the Linea Alba, which extends from the sternum to the pubes. Many of these fibres are

[1] Breschet, Thesis sur l'Hernie, Paris, 1819.

found crossing the linea alba and making a thin transverse layer on the tendon of the opposite side. From two to three inches in the adult, on either side of the linea alba, but more distant from it above than below, is another line, formed by the same tendons, which is the Linea Semi-lunaris. The navel, which originally was a hole for the passage of the umbilical vessels, and is commonly depressed into a pit, when the skin is on, appears in the dissection of the linea alba as a protuberance composed of a condensed cellular membrane. Just at the navel there is a line crossing the linea alba, and extending from one linea semi-lunaris to the other; at the lower end of the Cartilago-Ensiformis, there is another; and half way between this and the navel, a third: about one-third of the way down between the navel and the pubes, is a fourth, but it is generally imperfect. These are the Lineæ Transversæ, and they are formed by tendinous matter in the substance of the recti muscles, connecting them to their tendinous sheath in front.

The most interesting insertion of the tendon of the external oblique is the portion constituting Poupart's ligament, or the Crural Arch. The latter, as it gets to the pubes from the ilium, splits so as to leave a hole for the passage of the Spermatic Cord in the male, and of the Round Ligament of the Uterus in the female. This opening is named the External Abdominal Ring. The tendon forming its upper boundary is inserted into the symphysis pubis, and into the pubes of the opposite side, by fibres which are interwoven with and decussate those of its fellow. The tendon forming the lower margin of the ring is inserted into the spine of the pubes, and into its crista for an inch. The portion inserted into the crista of the pubes is Gimbernat's Ligament, which, it will be readily understood, means only a part of the crural Arch.

The Ring in the External Oblique is rather triangular than round; its base is formed by the body of the pubes, and its point is at the place where the tendon splits. The latter is kept from parting still farther by a fasciculus of tendinous fibres called Inter-columnar tendon, which runs across it, besides which from its circumference there proceeds the adhesion (*fascia spermatica*) of the superficial abdominal fascia, to the spermatic cord. The sides of this opening are called its Columns, and from their situation, internal and external, or upper and lower columns. In the female it is oval and scarcely half an inch long.

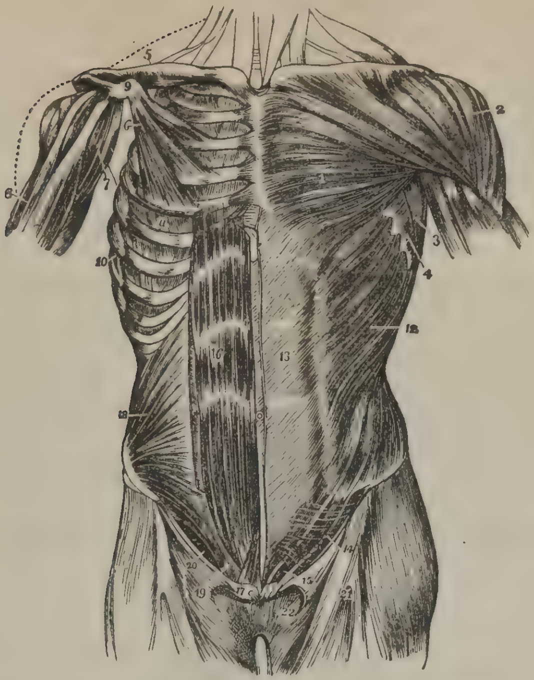
There are several small round holes in the tendon of this muscle, which afford passage to nerves and to veins. When, by the clearness of the dissection, the tendon has its characteristic gloss and polish, they are very distinct.

Use. This muscle compresses the viscera of the abdomen and brings the pelvis and thorax towards each other.[1]

[1] Varieties. Sometimes a considerable part of its middle and anterior portion is deficient, a vitiated conformation, to which it is subjected along with the other abdominal muscles. The inferior part of its tendon is incompletely developed by the absence of the superficial fibres which retain together the more deeply seated, by which it is weakened and caused to gape by one or more large oblong fissures: this variety gives occasion to a form of inguinal hernia, differing materially from what is common.

Latterly the attention of anatomists has been directed to a flat band of cellulo-fibrous matter called the *Ventrier* or Belly Band; which arises from the tendon of the external oblique, from the linea alba to the linea semi-lunaris, just above the external abdominal ring;

Fig. 124.



A view of the Superficial Muscles of the Left Side and of the Deep Muscles of the Right Side, on the Front of the Trunk. 1. Pectoralis major. 2. Deltoid. 3. Anterior edge of latissimus dorsi. 4. Serrated edge of serratus major anticus. 5. Subclavius muscle. 6. Pectoralis minor. 7. Coraco-brachialis. 8. Biceps flexor cubiti. 9. Coracoid process of the scapula. 10. Serratus major anticus after the removal of the obliquus externus abdominis. 11. External intercostal muscle of the fifth intercostal space. 12. External oblique of the abdomen. 13. Its tendon. The median line is the linea alba.– The line to the right of the number is the linea semi-lunaris. 14. The portion of the tendon of the external oblique, known as Poupart's ligament. 15. External abdominal ring. 16. Rectus abdominis. The white spaces are the linea transversæ. 17. Pyramidalis. 18. Internal oblique of the abdomen. 19. Common tendon of the internal oblique and transversalis. 20. Crural arch. 21. Fascia lata femoris. 22. Saphenous opening. The crescentic edge of the sartorial fascia is seen just above Fig. 22, and the interior or pubic point of the crescent is known as Hey's ligament.

2. *The Obliquus Internus*

Lies beneath the last, and its fibres pass in a cross direction to the fibres of the other. It arises tendinous, by the fascia lumborum, from the three inferior spinous processes of the loins and from all those of the sacrum; tendinous and fleshy, from the whole length of the crista of the ilium; and fleshy, from the upper or iliac half of Poupart's ligament. Though the fibres of this muscle, in general, decussate the fibres of the external oblique, all of them do not; for the lower are brought gradually to pursue the same direction towards the symphysis of the pubes.

Near the Linea Semi-lunaris, the muscular fibres cease, and the tendon begins.

It is inserted, by condensed fibrous cellular membrane, into the car-

and passes downwards to be inserted into the fascia femoris over the origin of the gracilis. Its outer margin reposes in front of the spermatic cord, and shoves it outwards as the band goes downwards. Thomson, Anat. du Bas Ventre. Paris, 1838.

tilage of the seventh, eighth, and ninth ribs; and by flesh into the tenth, eleventh, and twelfth. It is inserted also, membranous, into the side of the ensiforn cartilage, its whole length; and into the linea alba, from the sternum to the pubes.

The tendon of this muscle divides into two laminæ, which enclose the rectus muscle, and thereby form a sheath for it; imperfect, however, at the lower posterior part near the pubes.

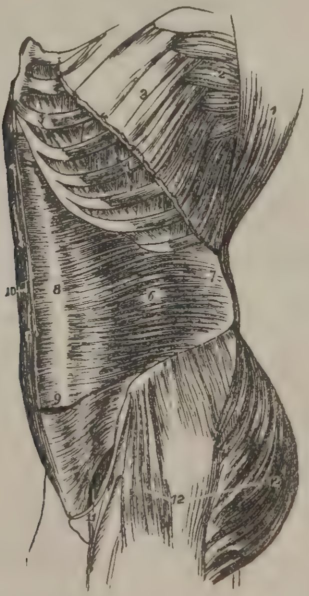
Its use is the same as that of the External Oblique.[1]

3. *The Transversalis Abdominis*

Proceeds directly across the abdomen and arises from the transverse process of the last dorsal, and of the four upper lumbar vertebræ; and from the back part of the crista of the ilium, all, by the Fascia Lumborum. It also arises, fleshy, from the anterior two-thirds of the spine or crista of the ilium, and from the exterior half of Poupart's ligament; and tendinous and fleshy alternately, from the inferior margin of the thorax, as formed by the cartilages of the six or seven inferior ribs, at their inner surfaces, where they are concerned in the origin of the diaphragm.

The fleshy part of this muscle occupies about one-third of its extent.

Fig. 125.



A lateral view of the Muscles of the Trunk, especially on the Abdomen. 1. Latissimus dorsi. 2. Serratus major anticus. 3. Upper portion of the external oblique. 4. Two of the external intercostal muscles. 5. Two of the internal intercostal muscles. 6. Transversalis abdominis. 7. Fascia lumborum. . Posterior part of the sheath of the rectus or anterior aponeurosis of the transversalis muscle. 9. The rectus abdominis cut off and in its sheath. 10. Rectus abdominis of the right side. 11. Crural arch. 12. Gluteus magnus—medius and tensor vaginæ femoris covered by the fascia lata.

[1] Varieties. It is sometimes defective at its lower part, and on other occasions redundant.

It is inserted into the side of the ensiform cartilage; filling up the vacancy between it and the cartilage of the sixth and the seventh ribs; and into the linea alba, from the extremity of the sternum to the pubes. The transversalis and the internal oblique also form below a common tendon, which is inserted for an inch into the crista of the pubes, behind the insertion of Gimbernat's Ligament; into the spine of the pubes; and into that part of the body of the pubes which forms the lower posterior boundary of the external abdominal ring. Just above this insertion the common tendon alluded to, splits into two laminæ, terminating in the linea alba; one of which goes before and the other behind the pyramidalis muscle, so that a sheath is thus formed for it.[1]

Use; to compress the contents of the abdomen.[2]

4. *The Rectus Abdominis*

Is seen beneath the tendons of the other muscles on either side of the linea alba. Its origin is by a flat tendon of an inch or more in breadth, from the symphysis pubis and the upper posterior line of the body of the pubes. The muscle increases gradually in its ascent, to the breadth of three inches or more. The tendinous intersections, confining it to the tendinous sheath in front, are found at the places mentioned as lineæ transversæ; but, for the most part, they do not extend through the muscle. When the origins of the Recti are examined from behind, it will be seen that the internal edge of one tendon, just above the symphysis pubis, overlaps the corresponding part of the other; that tendinous filaments arise from the linea alba near the pubes, to ascend in and fix for an inch or so its internal margin; also, that a small pyramidal ligament finishes more completely the structure just above the symphysis pubis; this ligament is called by Breschet, the Superior Pubic.

The rectus is inserted fleshy into the base of the cartilago-ensiformis, and into the cartilage of the fifth, sixth, and seventh ribs.

It draws the thorax towards the abdomen.[3]

5. *The Pyramidalis*

Is at the lower front part of the rectus, and is about three inches long. It arises somewhat thick, tendinous, and fleshy, from the upper part of the pubes, from near its spine to the symphysis, between the rectus behind, and the insertion of the external oblique before. Being fixed in the sheath formed by the splitting of the tendon of the transversalis muscle, it tapers to a point above, and is inserted into the linea

[1] The fascia iliaca near the anterior superior spinous process affords the surface devoted to the origin of the transversalis abdominis muscle, instead of the latter coming, as stated in the general description, from the crista of the ilium and from the contiguous portion of Poupart's Ligament.

[2] Varieties. Sometimes transverse tendinous fibres creep across its belly, and on other occasions a small transverse muscle is present, which decussates the larger, and is inserted into the twelfth rib.

[3] Varieties. If there be eight sternal ribs, then this muscle has an additional costal insertion. It sometimes sends a fasciculus to the fourth rib; and I have seen it ascending over the pectoralis major to the root of the neck, as occurs in mammiferous animals.

alba and internal edge of the rectus, for about the upper two-thirds of its own length.

It strengthens the lower part of the abdomen.[1]

At the linea semi-lunaris the tendon of the internal oblique and that of the transversalis unite intimately; and just beyond this junction the two laminæ are formed, which enclose the rectus muscle. The anterior lamina is the front layer of the tendon of the internal oblique, which, after passing half an inch or an inch, is joined to the tendon of the external oblique. They then go before the rectus muscle, and cover it from origin to insertion. The posterior lamina, made by the posterior layer of the tendon of the internal oblique, is united already at the linea semi-lunaris to the tendon of the transversalis; in this manner they pass behind the rectus muscle from the cartilago-ensiformis to a line half way between the umbilicus and the pubes. From this line, downwards, all the tendons go in front of the rectus muscle.

The obliquus externus tendon may be dissected from the common tendon of the others, without much difficulty, almost to the linea alba. The term insertion expresses, very imperfectly, the manner in which the tendons of these broad muscles all terminate in the linea alba from the thorax to the pelvis. For at the linea alba a very intimate intertexture of the tendons of all these muscles occurs, many of the fibres of the tendons escape from it and are found in front of the tendon of the external oblique of the other side. Thus disposed of, they serve very materially to keep the fasciculi of that tendon from gaping. A strong example of the arrangement is seen in the intercolumnar tendon of the external abdominal ring. The lineæ transversæ, by their adhesion in front to the sheath of the rectus, have the effect of a division of the latter into distinct muscles, which is readily seen in their spasmodic action in tetanus and in some affections of the abdomen; they influence to some extent also the umbilicus and linea alba, by being equivalent to insertions of muscle. For example, it will be seen that of the three lineæ transversæ above the umbilicus, the lower passes diagonally in a zigzag direction from the umbilicus upwards and outwards; the upper one is nearly parallel with the inferior cartilaginous margin of the thorax, and the second is nearly horizontal. The fourth is not far from the horizontal line, a little below the umbilicus.

The pyramidales muscles are best understood by their relation to the umbilicus. Acting upon the linea alba they draw the umbilicus downwards, and thereby antagonize the influence of the upper lineæ transversæ. We ought also to bear in mind that the exterior margin of the rectus, above, adheres with considerable firmness to the linea semilunaris, and that there is a very close adhesion around the umbilicus, to the contiguous margins of the recti abdominis. In general spasmodic action of the abdominal muscles, much of the pain collects on the umbilicus; this may be explained by its being thus the centre of many radiations of muscular contraction.

[1] Varieties. It is frequently defective, but sometimes two, three, or even four, are seen on a side. When defective, the rectus or obliquus internus is better developed than usual.

The Cremaster

Is a muscular sheath to the spermatic cord, extending from the external ring to the testicle, and its origin is commonly attributed exclusively to the internal oblique, as it is said to be a detachment of fibres from it; but it is also formed by fibres from the lower edge of the transversalis muscle. The history of its origin is as follows: in the descent of the testicle, the latter has to pass beneath that edge of the transversalis and of the internal oblique, which is extended from the iliac portion of Poupart's ligament, to the spine and the crista of the pubes. As the testicle descends, it comes in contact with a fasciculus of these fibres, and takes it along. This constitutes the Cremaster muscle, which, in adult life, and in a strong muscular subject, is seen descending on the outside of the spermatic cord, and spreading over the anterior part of the tunica vaginalis testis in arches, with their convexities downwards; then rising on the inner side of the cord to be inserted into the spine of the pubes.[1]

It draws up the testicle.

The Fascia Transversalis Abdominis.

The Fascia transversalis is placed immediately behind the transversalis muscle, between it and the peritoneum, and thus serves as the connecting medium of the two.

The view of the fascia transversalis from behind is extremely satisfactory. For a proper knowledge of this membrane, the profession is indebted to the labors of Sir Astley Cooper; and much of the zeal with which the anatomy of hernia has been investigated is attributable to him. The fascia transversalis is a thin tendinous membrane, most generally; occasionally it is merely condensed cellular membrane. It arises from the internal or abdominal edge of Poupart's ligament, and from the crista of the pubes just behind the insertion of the common tendon of the internal oblique and transversalis muscles, and is extended upwards on the posterior face of the transversalis muscle to the thorax. At its origin it is attached to the inferior edge of the transversalis and internal oblique, particularly the part between the internal ring and the symphysis pubis. It is also attached to the exterior margin of the rectus abdominis where it is deprived behind of its sheath, and it is there continued to the linea alba, where it runs into its fellow. The internal abdominal ring, or opening in this fascia, marks it out in some measure into two portions, of which that on the

[1] Jul. Cloquet, Anat. de l'Homme. This account, though easily verified in some subjects, and especially in such as are muscular, does not appear to be applicable to all. It does not agree with Mr. John Hunter's observation on the descent of the testicle; for he always found, while the latter was still in the loins, the cremaster running towards it. Moreover, in the buffalo of America, a testicle of which the late Dr. R. Harlan was obliging enough to furnish me with for dissection, I found that the cremaster, though remarkably robust and strong, forms none of those nooses or arches with their convexities downwards, but terminates at the testicle in a tendinous and somewhat abrupt manner. Taking all these points into consideration, it may be that a part of the cremaster is formed after the manner indicated by Mr. Hunter, and another part after that mentioned by M. Cloquet; or, indeed, cases may occur, presenting exclusively one or the other.

iliac side of the ring is not so thick as the other, or the one on the pubic side; and both portions are much more tendinous near the crural arch than they are higher up.

Were it not for the important influence of the fascia superficialis abdominis and the fascia transversalis, upon hernia, and the consequent necessity of a minute knowledge of them, their description might be much curtailed in considering them in their proper light, to wit: as sheaths of the abdominal muscles; for it is now sufficiently apparent that the first is contiguous to the external oblique; and the second to the transverse muscle, and in this view may be considered as the subserous layer of the peritoneum, beginning at the pelvis below, and ascending to the diaphragm, and thus serving as the connecting medium. Upon the same principle, fasciæ might be made of all the laminæ of cellular substance intermediate to the abdominal muscles, but it would be useless.[1]

An opening through it, which permits the spermatic cord to pass, is called the Internal Abdominal Ring, in order to distinguish it from the opening in the tendon of the external oblique, called the External Ring. The internal ring is rather nearer to the symphysis pubis than to the anterior superior spinous process of the ilium. The space between the internal ring and the external ring is about eighteen lines in the adult, and is very properly called the Abdominal, Inguinal, or Spermatic Canal, from giving passage to the Spermatic cord.

The anterior side of the canal is formed by the tendon of the external oblique; the inferior part, in the erect posture, is formed by Gimbernat's ligament; the posterior side is formed by the fascia transversalis; and above, this canal is overhung by the internal oblique and the transversalis muscle. The spermatic cord, after penetrating the fascia transversalis, does not cross, directly at right angles, the inferior edge of the internal oblique and transversalis, but it slips under them very obliquely; its inclination being towards the pubes, so that it can be considered as disengaged from the inferior edge of these muscles, only about the middle of the abdominal canal.

[1] A very elaborate and exact account of the construction of the parts concerned in hernia has been presented by Alexander Thomson, M. D., under the title of "Ouvrage complet sur l'Anatomie du Bas Ventre." Paris, 1838. The character of this work is not so much inventive as distinguished by great minuteness of research, and a different distribution of the matter from what is common, together with a most copious supply of new terms in place of old ones. Highly creditable as it is to his industry, we can scarcely do less than protest against the latter irregularity, and express our apprehensions that this objection, together with the unusual approaches which he has opened to the structure as a substitute for the settled ones, will restrict very much the reception of his work, and render it less acceptable to both teacher and student. The splitting and invention of fasciæ were considered for some time as almost exclusively an Anglican malady; but it appears, also, to have propagated itself to Paris in an exasperated form, in this production of Mr. Thomson, and in that of M. Velpeau (Anatomie Chirurgicale). both, unquestionably, works of much merit. The practical anatomist may justly ask, if all of the laminæ described as such be genuine fasciæ, what has become of the cellular substance which formerly entered so largely into the composition of the human body? Are they not verbal novelties rather than new discoveries? A sound anatomical verdict is yet to be given on these points: our own opinion is, that anatomy is too staid a science for mere caprices in description and names, and that such innovations cannot possibly become œcumenical. The introduction of a new name in the place of an old one is the highest act of medical authority, and is so seldom sanctioned by general suffrage, that an individual inclining to it may well pause, lest, in so doing, he may seal up his own publications, by the use of terms too little known to be convenient or desirable.

The opening in the Fascia Transversalis, or the Internal Ring, is not abrupt and well defined; but the fascia, where it transmits the spermatic cord, is reflected by a thin process, and terminates insensibly in its cellular substance; this may be considered as the beginning of the spermatic fascia. At the posterior or ventral face of the External Ring, the fascia transversalis is not in contact with the cord; but that part of the tendon of the internal oblique and transversalis which is inserted into the crista of the pubes, and forms a sheath for the pyramidalis muscle, is placed between them, and secures this opening.

The peritoneum covering the posterior face of the fascia transversalis is thrown into a duplicature or falciform process, passing from near the middle of the crural arch towards the umbilicus. This duplicature depends upon the round ligament of the bladder, which was once the umbilical artery of the fœtus. It is broader near the pelvis than it is above, has its loose edge turned towards the cavity of the abdomen, and ascends near the pubic margin of the Internal Ring. The effect of its existence is to divide the posterior face of the inguinal region into two shallow fossæ; one next to the ilium, and the other next to the pubes. The one next to the ilium contains the beginning of the internal abdominal ring, which is frequently marked by a little pouch of peritoneum, going along the spermatic cord for a few lines. The fossa on the inner or pubic side of the falciform process is just behind the external ring, but separated from it by the fascia transversalis, along with the tendon of the lower part of the internal oblique and of the transversalis muscle, where it is inserted into the pubes, and forms the sheath of the pyramidalis. The two fossæ indicate the points where inguinal herniæ commence; the proper inguinal protrusion begins in the external fossa, and the ventro-inguinal sometimes in the internal fossa.

On removing the peritoneum from the iliacus internus muscle, the spermatic vessels are seen to descend from the loins to the internal ring, where they are joined by the vas deferens coming from the pelvis. As they engage under the edge of the internal oblique muscle, after penetrating the ring, the cremaster muscle is detached to spread itself over them. The spermatic cord, thus constructed, passes through the abdominal canal in the manner mentioned, obliquely downwards and inwards; and, emerging from the external ring, it descends vertically, lying rather upon the outer column of the ring than upon its base.

On the posterior face of the fascia transversalis, between it and the peritoneum, is the Epigastric Artery. The epigastric arises from the external iliac as the latter is about to go under the crural arch; it ascends inwardly along the internal margin of the internal abdominal ring to the exterior margin of the rectus abdominis muscle, which it reaches after a course of two and a-half or three inches. The spermatic cord, in getting from the abdomen to the abdominal canal, therefore, winds, in part, around the epigastric artery; in the first of its course being at the iliac edge of the artery, and then in front of it. Two epigastric veins attend the artery, one on each of its sides, and end by a common trunk in the external iliac vein.

So much space has been devoted to the description of the parts concerned in inguinal hernia, that it might be most prudent to let it here cease. A fair desire to be accurate will, with some at least, be an apology for my stating, that in practice it will be found that the iliac half of Poupart's ligament is bent down towards the thigh by an adhesion to the iliac and to the sartorial fascia at their union; that the internal oblique and the transversalis muscle, besides the adhesion to Poupart's ligament there, arise, also, from the iliac fascia just above Poupart's ligament, from the anterior superior spinous process, almost to the spermatic cord at the internal ring. The fascia transversalis, just above them, adheres in line to the iliac fascia, and as it approaches the femoral vessels, is connected with Poupart's ligament, but not before; as it is previously separated from the latter by the whole thickness there of the transversalis and internal oblique, at their common origin. The distance of the inferior margin of the fascia transversalis from Poupart's ligament, increases more and more from the femoral vessels towards the anterior superior spinous process, being at the latter at least half an inch; and it is also kept afterwards, about the same distance from the crista of the ilium, as it adheres there to the circumference of the iliac fascia.[1]

The anatomical arrangement of the parts concerned in inguinal hernia in the female is the same as in the male, except that the round ligament of the uterus supplies the place of the spermatic cord, and there is no cremaster muscle.

SECT. III.—MUSCLES OF THE UPPER AND POSTERIOR PARIETES OF THE ABDOMEN.

These muscles are constituted by a single symmetrical one, and by four pairs: they can only be seen advantageously by removing the abdominal viscera.

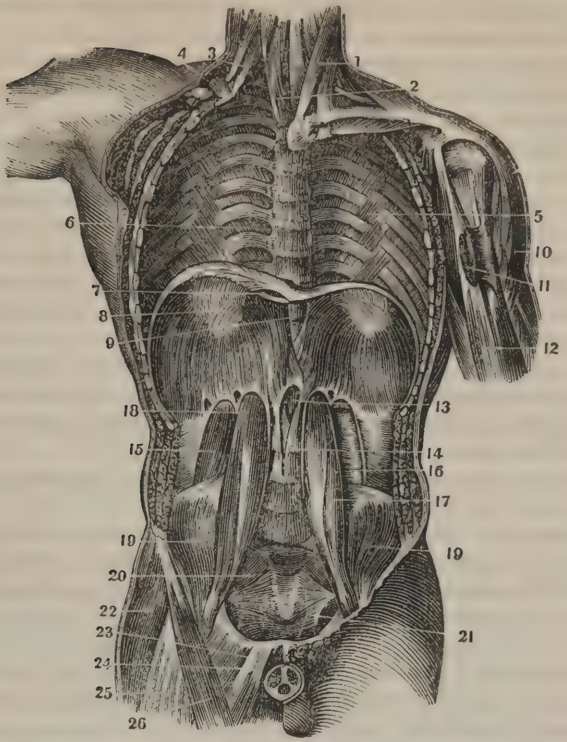
1. *The Diaphragm* (*Diaphragma*)

Is a complete, though movable septum, placed between the thoracic and abdominal cavities; it is extremely concave below and convex above, the concavity being occupied by several of the abdominal viscera. It is in contact above with the pericardium and the lungs, and below with the liver, spleen, and stomach.

It is connected with the inferior margin of the thorax, on all sides, as it exists in the natural skeleton; and has for its centre a silvery tendon, resembling in its outline the heart of a playing card. This cordiform tendon occupies a considerable part of the extent of the diaphragm, has its apex next to the sternum, and its notch towards the spine; and the muscular part of the diaphragm is inserted all around into its circumference. The cordiform tendon is nearly horizontal in the erect posture, its elevation being on a line with the lower end of the second bone

[1] For an account of both Inguinal and Femoral Hernia, the reader is referred to the United States Dissector, or Lessons in Practical Anatomy, by the present author. Revised edition, 1846.

Fig. 126.



A vertical section of the Front of the Trunk, showing its Posterior Parietes and the cavities of the Chest and Abdomen.—1. Sterno-cleido-mastoid. 2. Longus colli. 3. Scalenus anticus. 4. Upper portion of the serratus major anticus. 5. Intra-costales muscles or appendices to the internal intercostal muscles. 6. Internal intercostal muscles. 7. Foramen quadratum for the inferior vena cava. 8. Back part of the cordiform tendon of the diaphragm. 9. Middle of the diaphragm, showing the foramen œsophageum. 10. Deltoid. 11. Insertion of the pectoralis major. 12. Biceps flexor cubiti. 13. Foramen aorticum of the diaphragm. 14. Origin of the lesser muscle of the diaphragm. 15. Quadratus lumborum. 16. Its sheath. 17. Psoas magnus. 18. Origin of the psoas parvus. 19. Iliacus internus. 20, 21 Region of upper strait of pelvis. 22. Muscles of hip. 23. Adductor longus. 24. Pectineus. 25. Rectus femoris. 26. Sartorius.

of the sternum. On each side of this tendon some of the muscular fibres rise so high upwards before they join it, that they are on a horizontal level with the anterior end of the fourth rib. The fasciculi of muscular fibres are, for the most part, convergent from the circumference of the thorax, and are easily separated from one another.

In the diaphragm are three remarkable foramina. The first (the *foramen œsophageum*) is in the back of the muscle, between the spine and the notch of the cordiform tendon, a little to the left of the middle line. It gives passage to the œsophagus and the par vagum nerves along with it, and is rather a fissure or a long elliptical foramen made by the separation and reunion of the muscular fibres; for, above and below, at each end of the ellipsis, these fibres decussate one another in columns. To the right of this foramen, and a little above its horizontal level, in the back part of the cordiform tendon, is a very large and patulous foramen for the ascending vena cava (*foramen quadratum*).

Its form is between an irregular quadrilateral figure and a circle; its edges are composed of fasciculi of tendon, rounded off, and are not susceptible of displacement, or of alteration in their relative position to each other, by which means any impediment to the course of the blood in the ascending cava, which might arise from a different arrangement, is obviated. Almost in a vertical line below, and about three inches from the foramen for the œsophagus, is the third hole, in the diaphragm, which affords passage to the aorta (*hiatus aorticus*). It is just in front of the bodies of the three upper lumbar vertebræ, and is a much longer elliptical hole than the œsophageal. Its lowest extremity or pole is incomplete, being constituted by the tendinous crura of the diaphragm, and its upper, by a decussation of muscular fasciculi arising from them. Through it, besides the aorta, pass the thoracic duct, and the great splanchnic nerve of each side.

In the horizontal position of either the dead or the living body, the right side of the diaphragm ascends higher in the thorax than the left; but the weight of the liver makes it, in the vertical posture, descend lower than the other.

Thus circumstanced, the detailed origin of the Diaphragm is as follows: It arises fleshy from the internal face of the upper end of the Xiphoid cartilage; from the internal face of the cartilages of the seventh, eighth, and ninth ribs; from the osseous extremities of the tenth and eleventh, and from both the osseous and cartilaginous terminations of the twelfth rib. As the line described includes almost the whole of a circle, and the fibres all converge to the cordiform tendon, they, of course, will pass in different radiated directions, and be of different lengths, which it is unnecessary to specify. Between the sternal and costal portion on each side, there is a triangular fissure filled with fatty cellular tissue, and which sometimes leaves an opening for hernia. I have seen a case of the kind, in which the transverse part of the colon was the subject of protrusion into the thorax. It is probable that the great displacement of the abdominal viscera into the thorax, which sometimes occurs, may have a congenital origin in this fissure, and is subsequently, when the parts are accommodated to their unnatural situation, thought to be a lusus naturæ. The portion just described is called the Greater Muscle of the Diaphragm.

Besides these origins, the diaphragm has several from the vertebræ of the loins, constituting its crura; there being four on each side of the foramen for the aorta. The first pair, entirely tendinous, comes from the front of the body of the third vertebra of the loins, and is prevented from being very distinct in its origin, in consequence of running into the ligament in front of the bodies of all the vertebræ, or the Anterior Vertebral Ligament as it is called. The second pair of heads is on the outside of the first, and arises, tendinous, from the inter-vertebral ligament, between the second and third vertebræ. The third pair of heads arises tendinous from the upper part of the lateral face of the second lumbar vertebra. And the fourth pair of heads comes also tendinous, from the fore part of the root of the transverse process of the second lumbar vertebra. These tendinous heads terminate in what is called the Lesser Muscle of the Diaphragm, which is inserted into the notch of the cordiform tendon. It will now be understood that the aorta

passes between the two sides of the lesser muscle, and that the œsophagus occupies a hole in the upper part of its belly.[1]

The origin of the diaphragm is completed between its greater and lesser muscle, by a tense ligament, the Ligamentum Arcuatum, which passes from the root of the transverse process of the first lumbar vertebra to the inferior part of the middle of the twelfth rib; with the upper edge of this ligament the diaphragm is connected; and with the lower, the psoas magnus muscle, and the quadratus lumborum. At the margin of the other ribs, the diaphragm is connected with the transversalis abdominis.

Use. In consequence of the muscular fibres of the diaphragm passing in a curved direction from the circumference of the thorax to the cordiform tendon; and of those fibres forming a sheet, concave below and convex above, their contraction at the same moment enlarges the cavity of the thorax, and has a tendency to diminish that of the abdomen, which latter is prevented by the yielding of the abdominal muscles. In easy respiration, its contractions and relaxations produce alternately the actions of inspiration and of expiration. Its descent, also, assists in the expulsion of fæcal and other matters from the abdomen. By the experiments of Bourdon,[2] it appears that it only acts a secondary part in the latter; that its functions are limited to inspiration and the associated actions; but that in regard to its power of assisting in the expulsion of the contents of the abdomen, all that it does is at first to fill the lungs with air, and then the closure of the glottis prevents the air from being expelled from the lungs. Common observation in parturition shows us, that the expulsive effort of the abdominal muscles does not take place when inspiration is going on, for the former would prevent the latter; but the moment that expiration begins, it is arrested by the firm closure of the glottis, and then the abdominal muscles contract advantageously.

The Quadratus Lumborum

Is an oblong muscle, arising from the crista of the ilium, at the side of the lumbar vertebræ, by a tendinous and fleshy origin of three inches. It is inserted into the transverse process of each of the lumbar vertebræ and of the last of the back by a short tendinous slip: it is also inserted into the lower edge of the last rib near its head, beneath the ligamentum arcuatum.

It bends the loins to one side, and draws down the last rib.

It is covered behind by the tendinous origin of the transversalis abdominis, which separates it from the sacro-lumbalis and from the

[1] This origin of the lesser muscle of the diaphragm is given by Albinus, but it is difficult to make out fairly; for the most part it would be much more correct to say that it arises tendinous, from the first, second, and third vertebræ in front, and the corresponding inter-vertebral matter. The heads are generally much smaller on one side, the left, than the other. From which cause a large fasciculus of muscle passes from the right to the left side in ascending, and separates the hole for the aorta from that for the œsophagus.

[2] Recherches sur la Respiration et la Circulation, Paris, 1820.

longissimus dorsi. It may also be seen very well from behind, in the dissection of the back.[1]

The Psoas Parvus

Arises, fleshy, from the contiguous edges of the body of the last dorsal and of the first lumbar vertebra at their sides, and from their inter-vertebral ligament. It is at the anterior and internal edge of the psoas magnus; has a short belly, and a long tendon by which it is inserted into the linea innominata, about half way between the spine of the pubes and the junction of this bone with the ilium. The tendon, besides, is expanded into the fascia iliaca.

Its use seems to be to draw upwards the sheath of the femoral vessels, which is derived from the fascia iliaca, and, consequently, to draw upwards the vessels themselves; which probably diminishes the liability to injury from their too great or sudden flexion. This muscle is sometimes wanting.

The Psoas Magnus

Arises, fleshy, from the side of the bodies of the last dorsal and of the four upper lumbar vertebræ, and from the transverse processes of all the lumbar vertebræ. It forms an oblong fleshy cushion on the side of the lumbar vertebræ; and, constituting the lateral boundary of the inlet to the pelvis, it passes out of the pelvis, under Poupart's ligament, about its middle.

It is inserted, tendinous, into the back part of the trochanter minor of the os femoris, and fleshy for an inch below it.

It bends the body forwards, or draws the thigh upwards.[2]

The Iliacus Internus

Occupies the concavity of the ilium, being on the outside of the psoas magnus. It arises, fleshy, from the transverse process of the last lumbar vertebra; from the internal margin of the crista of the ilium; from the whole concavity of the latter; from its anterior edge at and above the anterior inferior spinous process; and from that part of the capsule of the hip joint near the latter process.

This muscle terminates in the tendon of the psoas magnus, just above its insertion into the trochanter minor.

This and the psoas magnus, from having a common tendon, might with propriety be considered as only one muscle. Their action is the same.[3]

[1] Varieties. Sometimes a broad tendon from it is inserted into the inferior margin of the body of the eleventh vertebra of the back. Sometimes a fasciculus of it touches the margin of the eleventh rib, near its head, and above the intercostal vessels.

[2] Varieties. Sometimes it is joined by muscular fasciculi from the first, second, and even third bone of the sacrum. Sometimes, where it borders on the pelvis, there is a small fasciculus, which continues distinct almost to the trochanter minor, and then sends its own tendon into the common tendon of the iliacus internus and psoas magnus.

[3] Varieties. Sometimes an additional fasciculus arises below the inferior anterior spinous process, and descends along the external margin of this muscle. This fasciculus varies

Of the Fascia Iliaca.

The Fascia Iliaca is a tendinous membrane, which lies on the iliacus internus and the psoas magnus muscle, and is continued into the tendon of the psoas parvus. Externally, it is connected to the margin of the crista of the ilium; at the internal edge of the psoas magnus, it is connected with the brim of the pelvis, and sinks into the cavity of the pelvis, being continuous with the aponeurosis pelvica; and below, it adheres to the edge of the crural arch, from the anterior superior spinous process of the ilium almost to the pubes, and is continued under it into the sartorial portion of the fascia femoris. It makes a line of adhesion from the anterior superior spinous process to the femoral vessels, with the fascia transversalis abdominis. The external iliac vessels are upon this fascia, between it and the peritoneum: and below them the fascia iliaca goes over that part of the pubes which gives origin to the pectineus muscle, and is continuous with the pectineal fascia, or that which covers the pectineus muscle. By introducing the finger or a knife handle into a cut through the fascia iliaca, its attachment to the crural arch, and its continuity with the fascia pectinea and sartoria, will be rendered very obvious.

The iliac vessels pass beneath the crural arch on the inner margin of the psoas magnus muscle, the vein being nearest the pubes and the artery at the outer side of the vein. The fascia iliaca, being blended into the crural arch as far as the vein, may indeed be traced to the crista of the pubes: it is so connected with the vessels that no opening for hernia exists between them, or indeed in all the space from the internal margin of the vein to the spine of the ilium. But at the inner side of the vein, between it and Gimbernat's ligament, an opening appears, called the Crural or Femoral Ring, and is the place where femoral hernia commences. This opening is generally occupied by a lymphatic gland, and a lamina of condensed but loosely attached cellular substance, continuous with the aponeurosis pelvica.

SECT. IV.—MUSCLES ON THE POSTERIOR FACE OF THE TRUNK.

The Trapezius, or Cucullaris,

Is a beautiful broad muscle, immediately under the skin; it covers the back of the neck and thorax; and extends from the bottom of the latter to the top of the former. Its anterior edge, above, is parallel with the posterior edge of the sterno-cleido-mastoideus. Its origin is joined with that of its fellow. Below, it overlaps in part the latissimus dorsi.

It arises by a tendinous membrane from the posterior or external occipital protuberance, and from eight or ten lines, sometimes more, of the superior semicircular ridge of the occiput. It arises tendinous also

somewhat in its size at different points, and is inserted into the linea aspera below the trochanter minor. In very rare cases, the iliacus internus is kept totally distinct from the psoas magnus, from origin to insertion.

from the five superior spinous processes of the neck through the intervention of the ligamentum nuchæ, and tendinous directly from the two lower spinous processes of the neck, and from all those of the back.

It is inserted fleshy into the external third of the clavicle, tendinous and fleshy into the inner edge of the acromion process, and into all the spine of the scapula. Its fibres having a very extended origin must of course converge in getting to these insertions; the upper fibres descend, the lower ascend, and the middle are horizontal.[1]

It draws the scapula towards the spine.

In the cervical portion of these muscles, formed by the origins of

Fig. 127.

A view of the Muscles of the Back as shown after the removal of the Integuments.—1. Occipital origin of the trapezius. 2. Sterno-cleido-mastoideus. 3. Middle of the trapezius. 4. Insertion of the trapezius into the spine of the scapula. 5. Deltoid. 6. Second head of the triceps extensor cubiti. 7. Its superior portion. 8. Scapular portion of the latissimus dorsi. 9. Axillary border of the pectoralis major. 10. Axillary border of the pectoralis minor. 11. Serratus major anticus. 12. Infraspinatus. 13. Teres minor. 14. Teres major. 15. Middle of the latissimus dorsi. 16. External oblique of the abdomen. 17. Gluteus medius. 18. Fascia of ditto. 19 Gluteus magnus. 20. Fascia lumborum.

[1] Varieties. It is sometimes short of the origin described, by from one to four, of the lower spinous processes of the back. Also the lower fasciculus is sometimes disjoined from the rest of the muscle, by a large triangular space.

both united, is an elliptical expanse of tendon, lying over the ligamentum nuchæ, and extended on each side. The ligamentum nuchæ itself, as mentioned elsewhere, is a vertical septum of ligamentous matter, extending from the central line of the occipital bone (*crista occipitalis*) to the spinous processes of all the vertebræ of the neck. At its upper part, where the spinous processes of the neck are short, this septum is very broad, and divides completely the muscles of the two sides of the neck.

The Latissimus Dorsi

Is situated under the skin at the lower part of the back, so as to cover the whole posterior portion of the latter. It arises by a thin tendinous membrane, from the seven inferior spinous processes of the back; and by a thick tendinous membrane from all those of the loins and sacrum. Its origin also extends in this condition along the outer inferior margin of the sacrum, and from the posterior third of the spine of the ilium.[1] Besides which, the latissimus dorsi has from the sides of the three or four inferior false ribs, as many fleshy heads which are connected with the inferior heads of the obliquus externus abdominis.

From this extended origin the fibres converge, so as to form the posterior fold of the axilla, and to terminate in a flat, thick tendon, of two inches in breadth, which is inserted into the lower part of the posterior ridge of the bicipital groove of the os humeri. The upper part of this muscle passes over the inferior angle of the scapula, and derives a fasciculus of fibres from it. It is there behind the teres major, but as it advances it winds around the inferior edge of the latter so as to get before it. Afterwards the tendons of the two adhere closely, but have a bursa between them at their termination. That portion of the tendon of the latissimus which is continuous with the lower edge of its fleshy belly, becomes uppermost by a half spiral turn in the latter; while the upper portion is by the same arrangement made lowest. At the place of its insertion, it is commonly connected to the pectoralis major, by an adhesion crossing the bicipital groove, at its bottom. The inferior margin of its tendon detaches a slip to the brachial fascia, and the superior margin another to the smaller tuberosity of the os humeri.

It draws the os humeri downwards and backwards.[2]

That portion of its origin, being the tendinous membrane coming from the spinous processes of the loins, is the fascia lumborum, and is common to the latissimus, the internal oblique and the transverse muscle of the abdomen, and several other muscles to be mentioned.

The origin of the two latissimi muscles conjointly makes a beautiful lozenge-shape expansion of tendon, occupying its entire spinal region, the longest diameter is vertical and just over the spinous processes, the lateral diameter extends from one crista of the ilium to the other.

[1] This origin frequently is tendinous at the back part of the ilium, and fleshy in front.

[2] Varieties. Sometimes from its anterior extremity a fleshy or tendinous slip is detached in front of the coraco-brachialis, and is inserted into the posterior face of the tendon of the pectoralis major. The brachial vessels and nerves are liable to compression from this arrangement, which is said to be natural to birds and moles. Another variety is where a slip runs from this muscle, adheres to the coraco-brachialis, and is inserted tendinous into the coracoid process of the scapula.

The Serratus Inferior Posticus.

The origin of this muscle is inseparably united to that of the latissimus dorsi by the fascia lumborum, and comes from the two inferior spinous processes of the back, and the three superior of the loins.

It is inserted by fleshy digitations into the under edge of the four inferior ribs.

It draws the ribs downwards, and is an antagonist to the diaphragm in some respects, but more particularly to the serratus superior posticus.

The removal of the trapezius brings into view several muscles: the most superficial of which are the rhomboid, which, being two together, look very much like one.

The Rhomboideus Minor

Is above the other. It is a narrow muscle, which arises by a thin tendon from the three inferior spinous processes of the neck, and, passing obliquely downwards, is inserted into the base of the scapula, opposite the beginning of its spine.

The Rhomboideus Major

Arises, also, by a thin tendon from the last spinous process of the neck, and from the four superior of the back, and is inserted into all the base of the scapula below its spine.

These muscles draw the scapula upwards and backwards.

The Levator Scapulæ

Is placed between the posterior edge of the sterno-cleido-mastoideus and the anterior of the trapezius; its lower end is just above the rhomboideus minor. It arises by rounded tendons from the three, four, or five superior transverse processes of the neck, between the scaleni muscles and the splenius colli.

It is inserted, fleshy, into that part of the base of the scapula above the origin of its spine. As its name expresses, it draws the scapula upwards. A good view of this muscle may be obtained in the front dissection of the neck.[1]

The Serratus Superior Posticus

Arises by a thin tendon from the three inferior spinous processes of the neck, and the two superior of the back, and is inserted into the second, third, fourth, and fifth ribs, by tendinous and fleshy slips, a little beyond their angles.

This muscle draws the ribs upwards.

[1] Varieties. Sometimes it arises from only two superior transverse processes; occasionally its fasciculi are separated from the neck to the scapula; or a long one is detached towards the spine, thereby presenting a disposition similar to what is met with in the dolphin.

From the Serratus Superior to the Inferior, is an aponeurotic expansion described by Rosenmuller, which connects them together, and has induced some anatomists to consider them as but one muscle. It is thin and diaphanous; but has the fibrous structure very apparent, and running in a transverse direction from the spinous processes to the angles of the ribs. The superior margin of the latissimus dorsi also runs into this fascia, so as to render its own bounds somewhat undefined. This fascia, along with the ribs and vertebræ, forms that gutter in which are contained the deep-seated muscles of the back.

The Splenius

Has its inferior extremity beneath the serratus superior posticus, but the principal part of it is covered by the trapezius. It arises from the spinous processes of the five inferior cervical,[1] and of the four superior dorsal vertebræ.

It is inserted into the back of the mastoid process and continuous ridge of bone, extending upon a small part of the adjacent portion of the os occipitis, also into the transverse processes of the two superior cervical vertebræ. It is customary to consider[2] the part which goes to the head as Splenius Capitis, and the part below as Splenius Colli: the latter, in that case, is said to arise from the third and fourth dorsal vertebræ. It draws the head and neck backwards.

Between the spinous processes of the vertebræ and the angles of the ribs, on either side, the deep fossa is filled up entirely by muscles. Some of them are large and powerful, and the most striking are the Sacro-Lumbalis and the Longissimus Dorsi.

The Sacro-Lumbalis and Longissimus Dorsi

Have a common origin from the back of the pelvis and of the lumbar vertebræ, and extend to the top of the thorax. They thus arise tendinous posteriorly, and fleshy anteriorly, from the posterior surface of the sacrum by its external margin and spinous processes: they arise, also, tendinous, from the spinous processes, and fleshy, from the ends of the transverse processes of all the vertebræ of the loins; and principally tendinous from the posterior part of the spine of the ilium. The external margin of the belly is fleshy; and all the part nearest to the spine is wholly tendinous below, but, higher up in the loins, it is so only on the surface. The tendon is very strong, and divided into fasciculi, chiefly near the spinous processes of the lumbar vertebræ. From the under surface of this common belly, two heads, tendinous and fleshy, are inserted into the inferior edge of the transverse process of each lumbar vertebra, the smaller near its root, and the larger near its extremity. On a level with the lower rib, and, indeed, somewhat below it, a fissure occurs in the muscle which divides it into its two parts.

[1] In the case of any one of the five superior spinous processes of the neck, it is to be understood that the ligamentum nuchæ is the medium of origin in this as in other muscles.

[2] Albinus, loc. cit.

The Longissimus Dorsi is nearest the spine; it is inserted, by small double tendons, proceeding from its internal surface, into the ends of the transverse processes of all the vertebræ of the back, except the first. It also from its outer edge sends long slender tendons, by which it is inserted into the under edges of all the ribs, beyond their tubercles, except the two inferior.

The Sacro-Lumbalis is inserted from its outer edge into all the ribs at their angles, by long and thin tendons, which are successively longer, the higher they are inserted.

By turning over this muscle towards the ribs, from the other, one may see coming from the eight lower ribs as many slips, which run into the under surface of the sacro-lumbalis: they are the Musculi Accessorii ad Sacro-Lumbalem.

These two muscles keep the spine erect, and draw down the ribs.[1]

The Spinalis Dorsi,

Between the ends of the spinous processes and the edge of the longissimus dorsi, is a muscle almost entirely tendinous, and scarcely to be distinguished from the latter, both in consequence of its close connection with it, and of its insignificant size. At its lower part, it is absolutely a portion of the longissimus, and can be separated from it only by a forced division. It is a mere string lying along the sides of the spinous processes, and is called, from its origin and insertion, the Spinalis Dorsi.

It arises tendinous from the spinous processes of the two superior lumbar, and of the three inferior dorsal vertebræ, and is inserted, tendinous, into the spinous processes of the nine superior dorsal vertebræ, except the first.

It tends to keep the spine erect.[2]

The Cervicalis Descendens

Is a small muscle placed at the upper portion of the thorax, between the insertions of the sacro-lumbalis, and of the longissimus dorsi into the upper ribs; it looks at first very much like a continuation or appendix of the first, running to the cervical vertebræ.

This muscle arises from the upper edges of the four superior ribs by long tendons; it forms a small belly which is inserted by three distinct tendons respectively into the transverse process of the fourth, fifth, and sixth vertebræ of the neck, between the levator scapulæ and splenius colli.

It draws the neck backwards.

[1] Varieties. The origin is uniform, but the insertions vary in their number. Sometimes, a fasciculus commences by a tendinous beginning from the fourth rib, and is inserted into the transverse process of the sixth vertebra of the neck; a fasciculus from the sacro-lumbalis joins the fascia extended between the two serrati, or reaches to the splenius colli: the two muscles are sometimes joined closely by an intermediate fasciculus.

[2] This muscle, together with the sacro-lumbalis and the longissimus dorsi are spoken of collectively as the Erector Spinæ.

The Transversalis Cervicis

Is on the inner side of the last, and in contact with it, being about the same size, and having very much the same course and appearance. It is considered as an appendage to the longissimus dorsi.

It arises from the transverse processes of the five superior dorsal vertebræ by distinct tendons, and forms a narrow fleshy belly, which is inserted by distinct tendons, also, into the transverse processes of the five middle cervical vertebræ.

It draws the head backwards.

The Trachelo-Mastoideus

Is at the inner side of the last muscle, in contact with it.

It arises by distinct tendinous heads, from the transverse processes of the three superior vertebræ of the back, and of the five inferior of the neck; and is inserted, by a thin tendon, into the posterior edge of the mastoid process immediately within the insertion of the splenius capitis.

The dorsal origins are frequent, deficient, or irregular.

It draws the head backwards.

The Complexus,

A fine large muscle, is situated at the inner face of the trachelo-mastoideus, and is readily recognized, by showing itself between the bellies of the two splenii capitis, just below the occiput. A quantity of tendinous matter exists in its middle, which gives it the complicated appearance from whence its name is derived.

It arises, by tendinous heads, from the seven superior dorsal, and the four inferior cervical vertebræ, by their transverse processes; also, by a fleshy slip from the spinous process of the first dorsal. It is inserted into the inferior part of the os occipitis, by the surface between the upper and lower semicircular ridges, on the outside of the vertical ridge (*crista occipitalis*) which exists in the middle of the bone.

It draws the head backwards.

The Semi-spinalis Cervicis

Is a muscle which passes obliquely from transverse to spinous processes, and is situated between the complexus and the multifidus spinæ; the course of its fibres renders it difficult to be distinguished from the latter.

It arises from the transverse processes of the six upper vertebræ of the back, by tendons which adhere to those of the adjacent muscles; and passes up to the neck, to be inserted into the sides of the spinous processes of the five middle cervical vertebræ.

It extends the neck obliquely backwards.

The Semi-spinalis Dorsi

Is lower down on the spine, and with difficulty distinguished from the multifidus; like the last, it passes from transverse to spinous processes. It lies under the longissimus dorsi, between it and the multifidus.

This muscle arises by tendons connected with those of the other muscles, from the transverse process of the seventh, eighth, ninth, and tenth dorsal vertebra; and passes upwards obliquely, to be inserted, tendinous, into the sides of the spinous processes of the two lower cervical, and of the five upper dorsal vertebræ.

It draws the spine obliquely backwards.

The Multifidus Spinæ

Lies under the muscles as yet mentioned, close to the bones of the spine; in order to see it well, they, therefore, should all be cut away.

It has its commencement, tendinous and fleshy, on the back of the sacrum, being connected to its spinous processes and posterior surface, also to the back part of the spine of the ilium. It there forms a belly of sufficient magnitude to fill up much of the cavity between the spinous processes of the sacrum and the posterior part of the ilium. It arises also from the roots of the oblique and transverse processes of all the vertebræ of the loins, of the back, and of the four inferior of the neck.

The multifidus is inserted, tendinous and fleshy, into the roots and sides of the spinous processes of all the vertebræ of the loins, of the back, and of the five inferior of the neck.

This muscle consists of a great number of small bellies, which are parallel to each other, and each of which arises from a transverse or oblique process, and goes obliquely to the spinous process either of the first or second vertebra above it.

It twists the spine backwards, and keeps it erect.

Between the head and the first and second vertebræ, and between the latter two, there are on either side, four small muscles, intended for the motion of these parts upon each other. They are brought into view by the removal of the complexus.

The Rectus Capitis Posticus Major

Arises, tendinous and fleshy, from the extremity of the spinous process of the vertebra dentata, and is inserted into the inferior transverse or semicircular ridge of the os occipitis, and into a part of the continuous surface of bone just below it.

Its shape is pyramidal, the apex being below. It turns the head, and also draws it backwards.

The Rectus Capitis Posticus Minor

Is at the internal edge of the first. It arises, tendinous, from the tubercle on the back part of the first vertebra, and is inserted into the

internal end of the inferior transverse or semicircular ridge of the os occipitis, and into a part of the surface between it and the foramen magnum.

It is also pyramidal, with the apex downwards. It draws the head backwards.

The Obliquus Capitis Superior

Arises from the transverse process of the first cervical vertebra, and is inserted into the outer end of the inferior semicircular ridge of the os occipitis, behind the posterior part of the mastoid process, and beneath the splenius muscle.

It draws the head backwards.

The Obliquus Capitis Inferior

Arises from the side of the spinous process of the vertebra dentata, and is inserted into the back part of the transverse process of the first vertebra of the neck.

It rotates the first vertebra on the second.

The Inter-Spinales

Are small short muscles, placed between the spinous processes of contiguous vertebræ. In the neck they are double, in consequence of the spinous processes there being bifurcated; in the back they are almost entirely tendinous; in the loins they are single and well marked.

They draw the spinous processes together, and keep the spine erect.

The Inter-Transversarii

Are also short muscles, placed in a similar manner between the transverse processes of the vertebræ. In the neck they are double; in the back they are small, tendinous, and not well marked; and in the loins they are single and well seen.

They draw the transverse processes together, and will, of course, bend the spine to one side.

The Levatores Costarum

Are small muscles concealed by the sacro-lumbalis and longissimus dorsi, and pass from the transverse processes of the last cervical and of the eleven superior dorsal vertebræ, to the upper edges of the next ribs. They are twelve on either side of the spine, are tendinous in their origins and insertions, with intermediate muscular bellies.

The upper ones are small and thin. They increase in magnitude as they descend. From the inferior edge of nearly all these muscles, a fleshy slip is detached, which passes over the rib next below its origin, to the second rib below, and occasionally to the third. These slips are called Levatores Costarum Longiores. The others which descend from

the transverse process to the rib next below are called Levatores Costarum Breviores.

These muscles are parallel in their obliquity, with the external intercostals, and are not very obviously separated from them. They perform the same service, that of elevating the ribs.

The *Rotatores Dorsi* of Professor Theile, of Bern, pass from the transverse process of a vertebra below, to the under margin of the arch of the vertebra above. They are eleven in number on each side, beginning at the second dorsal vertebra, and ending at the twelfth. It may be considered as questionable whether any advantage will arise to descriptive anatomy by thus separating from the Multifidus Spinæ, fasciculi heretofore considered a part of it, but which Professor Theile says are marked off by a layer of cellular tissue. As much may be said at least of all the numerous strips making up the multifidus spinæ.

CHAPTER III.

OF THE FASCIÆ AND MUSCLES OF THE UPPER EXTREMITIES.

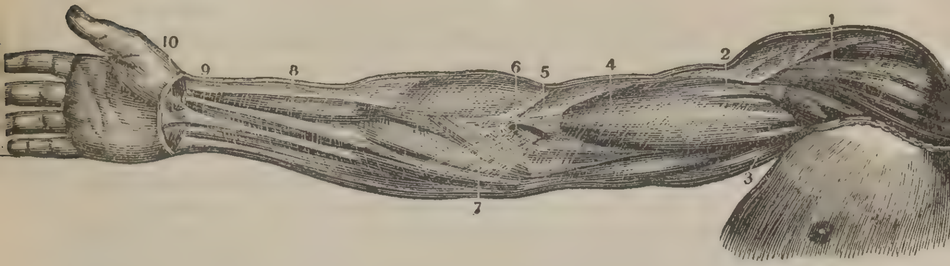
SECT. I.—FASCIA.

The muscles of each upper extremity are invested by an aponeurotic membrane called the Brachial Fascia, which extends from the shoulder to the hand. It might be very properly divided into the Humeral fascia, or that surrounding the shoulder; the Brachial, or that around the arm; the Antebrachial or that around the fore arm, and the Fascia of the Hand (*fascia manus*). It begins at the base and spine of the scapula, the margin of the acromion process, the acromial extremity of the clavicle, and from the cellular membrane in the arm-pit, and extends itself over all the muscles of the dorsum of the scapula, and over the deltoid muscle. A division of it is found covering the supra-spinatus muscle, being of a well-marked ligamentous character, and extended from the margins of the fossa supra-spinata. The tendons of the latissimus dorsi and pectoralis major each send off from their margins an expansion which is lost in it. Below the spine of the scapula it is strong and well marked, but on the deltoid muscle, as well as on the muscles of the arm, its desmoid character is by no means so well developed, though it still retains the appearance of a distinct membrane, and can be raised up as such from the muscles. On the fore arm its ligamentous appearance is well preserved, and extends from the elbow to the wrist inclusively. Its longitudinal fibres there are well secured by transverse ones.

Above the condyles of the os humeri, the Fascia Brachialis sends down to the bone a strong tendinous partition to each ridge, and which runs the length of the latter from its upper end to the condyle. These

processes separate the muscles on the back of the arm from such as are on the front of it, and are sometimes called the Ligamentum inter-musculare internum and externum. They afford origin to many

Fig. 128.



An anterior view of the Fascia Brachialis. 1. Portion covering the deltoid muscle. 2. Portion covering the upper part of the biceps. 3. Portion covering the coraco-brachialis. 4. Portion covering the lower part of the biceps. 5. Tendon of the biceps. 6. Opening for the vein. 7. Aponeurosis as strengthened by the expansion from the tendon of the biceps. 8. Fascia over the flexor sublimis. 9. Fascia over the flexor carpi radialis. 10. Commencement of the palmar fascia.

muscular fibres. At the bend of the elbow, the fascia brachialis is joined by a fasciculus of tendinous matter from the ulnar margin of the tendon of the biceps flexor cubiti, and which, in the contraction of the muscle, will keep the fascia tense.

At the lower extremity of the fore arm, the transverse fibres of the ante-brachial fascia, after diminishing sensibly, become more numerous, and by their attachments to the several ridges on the back of the radius and of the ulna, form the Ligamentum Carpi Dorsale. This ligament is extended from the outer or styloid margin of the radius, transversely to the inner margin of the ulna, to the pisiform bone, and to the fifth metacarpal. It consists, in some measure, of two portions: of which the superior is the smaller and thinner, has its fibres descending from the radius to the ulna, and is crossed, in part, by the fibres of the inferior or greater portion. As this ligament adheres with great strength to the ridges on the back of the bones of the fore arm, six trochleæ for the tendons of the extensor muscles are thus formed. The first, or that next to the styloid process of the radius, contains the tendons of the first two extensors of the thumb. The second is larger, and transmits the tendons of the two radial extensors of the carpus. The third is small and oblique, for the tendon of the third extensor of the thumb. The fourth is the largest, and is for the tendons of the extensor communis of the fingers and that of the indicator. The fifth is between the radius and the head of the ulna, and is for that tendon of the extensor communis which goes to the little finger. The sixth is on the back of the ulna, and is for the tendon of the extensor carpi ulnaris.

The inferior margin of this dorsal ligament of the wrist does not terminate abruptly, but resuming its fascia-like character, is continued over the back of the wrist, and over that of the hand to the fingers. In this progress it furnishes an envelop to the extensor tendons, and is very much blended with the oblique fasciculi, by which they communicate with each other.

The Fascia Brachialis affords origin, in part, to the muscles on the dorsum of the scapula below its spine; on the arm it is not so intimately connected with the muscles, but on the fore arm they again begin to arise, in part, from it. In its whole course partitions, constituting the sheaths of the muscles, and which consist, for the most part, of common cellular and adipose membrane, go from it down to the periosteum and inter-osseous ligament. It adheres very tightly to the ulna, from the olecranon to the styloid process. On its cutaneous surface are found all the superficial veins, nerves, and lymphatics of the arm. Bichat considers this membrane as the best example of the continuity of ligamentous with cellular tissue, and consequently of the affinity of the two, a fact now sufficiently proved by the microscope.

The flexor tendons of the hand and fingers are held down by the Ligamentum Carpi Volare or the Anterior Annular Ligament of the Wrist. It is a very strong fasciculus of ligamentous fibres, which subtends the concavity of the carpal bones in front, and converts it into the large oval foramen which contains the tendons. It is attached by one end at the ulnar side of the wrist, to the hook-like process of the unciforme and to the cuneiforme; also, but more slightly, to the pisiforme. Its fibres go straightly across the wrist to be attached by their other extremities to the radial end of the trapezium, and of the scaphoides; and may be readily distinguished from the fascia brachialis by their uniformly transverse course; by their superior whiteness; by their increased thickness; and by their great strength and unyielding nature. Yet the superior margin of this ligament is partially continuous with the fascia ante-brachialis, and the inferior margin with the aponeurosis palmaris. Several of the little muscles of the hand arise from its front surface, while the posterior is in contact with the flexor tendons.

The Fascia or Aponeurosis Palmaris is placed just below the skin, adhering firmly and closely to it, and covers the middle of the palm of the hand. It is triangular, and has its apex above, where it arises from the inferior margin of the volar or anterior annular ligament of the wrist, and from the tendon of the palmaris longus; it spreads out in its descent, and reaches the lower ends of the metacarpal bones, where it is divided into four portions, the vessels and nerves pass to the fingers between these primary divisions of the aponeurosis. Each of these portions bifurcates, and passes to the head of its appropriate metacarpal bone, to be fixed to it just in advance of the inferior palmar ligaments. The vacuity of the bifurcation permits the flexor tendons to pass to the finger, and its branches are held together by transverse and reticulated fibres, the interstices of which are filled with fat. The lateral margins of this aponeurosis send off a thin membrane, for the purpose of covering the muscles of the thumb and of the little finger; or, in other words, the thenar[1] and the hypo-thenar eminences in the palm of the hand.

[1] From θενω, *I strike.*

SECT. II.—OF THE MUSCLES OF THE SHOULDER.

The Deltoides

Is a muscle which is extended over the top of the shoulder joint, and forms there the subcutaneous cushion of flesh which protects and gives rotundity to the articulation. It arises from the inferior edge of the whole spine of the scapula, from the outer circumference of the acromion process, and from the exterior third of the clavicle. Its origin, for the most part, is tendinous and fleshy mixed; but at its posterior part it is entirely tendinous.

It is inserted, by a tendinous point, into the triangular rough surface on the outer side of the os humeri near its middle. Its general configuration is triangular, and when spread out, its upper margin is much more extensive than one would suppose, as it is opposed to the entire insertion of the trapezius. Its fibres do not converge regularly to its insertion like the radii of a circle, but the whole muscle is divided into several parts; the interposition of inter-muscular tendons into which, affecting the course of the fibres, makes several portions of the deltoid look penniform, and others, like smaller deltoids, introduced into the larger.

The deltoid covers the insertion of the pectoralis major, latissimus dorsi, and teres major, besides that of the other muscles of the shoulder. It also conceals the origin of the biceps flexor cubiti and of the coraco-brachialis. Its insertion is between the triceps extensor and the biceps flexor, and above the origin of the brachialis internus.[1]

It raises the os humeri.

Between the superior edge of the deltoid, the acromion process, and the subjacent tendons on the top of the articulation, there is a large Bursa Mucosa, which is sometimes partitioned off into two.

The Supra-Spinatus Scapulæ

Arises, fleshy, from the whole fossa supra-spinata, which it fills up; and from its margins. Forwards it terminates in a thick robust tendon closely connected with the capsular ligament of the joint, and which passes under the jugum formed by the articulation of the acromion with the clavicle.

It is inserted, tendinous, into the inner face of the great tuberosity of the os humeri.

It raises the arm, and turns it outwards.

The Infra-Spinatus Scapulæ

Arises, fleshy, from all that portion of the dorsum scapulæ below its spine, from the spine as far as the cervix, and from the several margins of the fossa infra-spinata. Its fibres pass obliquely to a middle ten-

[1] Varieties. Sometimes a fasciculus arises between the infra-spinatus and the teres major, or from the inferior costa of the scapula, and joins itself to the deltoid.

don, which adheres closely to the capsular ligament, and goes under the projection of the acromion.

This tendon is inserted, into the middle facet of the greater tuberosity of the os humeri.

The infra-spinatus rolls the os humeri outwards and backwards. There is a bursa between its tendon and the scapula.

The Teres Minor

Is situated at the inferior margin of the infra-spinatus, in the fossa of the inferior costa scapulæ, and looks very much like a part of the infra-spinatus, to which it occasionally adheres so closely as to be separated with difficulty. It arises, fleshy, from the whole of the fossa, and the margins of the inferior costa, in the space from the cervix of the bone to within an inch or so of its angle.

It is inserted tendinous and fleshy, into the outer facet of the great tuberosity of the os humeri, just below the infra-spinatus.

It draws the os humeri downwards and backwards, and rotates it outwards.

The Teres Major

Is situated at the inferior edge of the teres minor. It arises, fleshy, from the posterior surface of the angle of the scapula, and from a small part of its inferior costa; the interstice between it and the teres minor is considerable.

It is inserted, by a broad tendon, into the internal ridge of the groove of the os humeri, along with the tendon of the latissimus dorsi. Their tendons, at first, are closely united, but afterwards there is an intermediate cavity lubricated with synovia. The tendon of the latissimus dorsi is anterior, and the lower edge of the tendon of the teres extends farther down the arm than it.

It rolls the os humeri inwards, and draws it downwards and backwards.

The Sub-Scapularis

Occupies all the thoracic surface of the scapula, being between it and the serratus major. It arises, fleshy, from the whole base, superior and inferior costa, and costal surface of the scapula; it is divided into several columns, which look somewhat like distinct muscles, but they all terminate in a thick robust tendon that adheres to the inferior surface of the capsular ligament.

This tendon is inserted into the lesser tuberosity of the os humeri.

The subscapularis rolls the bone inwards and draws it downwards. Between it and the neck of the scapula, there is a bursa, which, as mentioned, communicates with the articulation.

SECT. III.—OF THE MUSCLES OF THE ARM.

The Biceps Flexor Cubiti.

This muscle is just beneath the fascia and integuments, and forms the swell so obvious in the middle front part of the arm. It arises by two heads. The first, called the long, is a round tendon which comes from the superior extremity of the glenoid cavity of the scapula, passes through the shoulder joint and through the groove of the os humeri; the second head arises tendinous from the extremity of the coracoid process of the scapula, in company with the coraco-brachialis muscle. The fleshy bellies in which these tendons terminate unite with each other, several inches below the shoulder joint, to form a common muscle. At first they are only connected by loose cellular substance; but, about half way down the arm, they are inseparably united.

The biceps terminates below in a flattened cylindrical tendon, which

Fig. 129.

A view of the Muscles on the Front of the Arm.—1. Clavicle. 2. Coracoid process and origin of the short head of the biceps. 3. Acromion scapulæ. 4. Head of the os humeri. 5. Tendon of the biceps muscle in the bicipital groove. 6. Ligamentum ascititium dissected off. 7. Cut portion of the pectoralis major. 8. Long head of the biceps. 9. Insertion of the deltoid. 10. Cut portion of the tendinous insertion of the pectoralis minor. 11. Coraco-brachialis 12. Short head of the biceps. 13. Latissimus dorsi. 14. Inner portion of the triceps. 15. Body of the biceps. 16. Outer portion of the triceps. 17. Brachialis internus. 18. Origin of the flexor muscles. 19. Brachialis internus near its insertion. 20. Tendon of the biceps. 21. Fasciculus from the biceps tendon to the fascia antebrachialis. 22. Flexor carpi radialis. 23. Palmaris longus. 24. Supinator radii longus.

passes in front of the elbow joint, to be inserted into the posterior rough part of the tubercle of the radius. A bursa mucosa is placed between the tendon and the front of the tubercle, the surface of the latter being covered with cartilage. From the ulnar side of this tendon proceeds the aponeurosis running into that of the fore arm.

The relative position of the biceps is as follows. Its long head is first within the cavity of the capsular ligament, and then between the tendons of the latissimus dorsi and teres major behind, and pectoralis major in front; where it is bound down by strong ligamentous fibres. The tendon below is superficial, and may be easily felt by flexing the fore arm, but its insertion dips down between the pronator teres and supinator radii longus.

This muscle flexes the fore arm.[1]

The Coraco-Brachialis

Is situated on the upper internal side of the arm, at the inner edge of the short head of the biceps muscle, with which it is connected for three or four inches. It arises tendinous and fleshy from the middle facet of the point of the coracoid process of the scapula, and in common with the short head of the biceps muscle.

It is inserted, tendinous and fleshy, into the internal side of the middle of the os humeri, by a rough ridge, just below the tendons of the latissimus dorsi and teres major, and in front of the brachialis externus or third head of the triceps. The lower end of this muscle is attached to the inter-muscular ligament of the internal side of the os humeri, which separates the brachialis internus from the third head of the triceps.

This muscle draws the arm upwards and forwards.[2]

The Brachialis Internus

Is situated immediately beneath the biceps, and is concealed by it, excepting its outer edge. It has a bifurcated fleshy origin from the middle front face of the os humeri, on each side of the insertion of the deltoid, and its origin is continued fleshy from this point downwards, from the whole front of the bone to within a very small distance of its articular surface.

It is inserted by a strong short tendon into the rough surface at the root of the coronoid process of the ulna. A bursa sometimes exists between the tendon of the brachialis internus, that of the biceps, the supinator brevis, and the elbow joint.

The brachialis flexes the fore-arm, and, by passing in front of the

[1] Varieties. Sometimes the division of the muscle is continued to the elbow; sometimes there is a third head, coming either from the internal face of the os humeri, or from the brachialis internus; very rarely, the number of heads has been multiplied to five, thereby making a close approximation to the arrangement in birds. This muscle is very liable to anomalies.

[2] Varieties. This muscle being generally penetrated by the musculo-cutaneous nerve, the perforation thus made sometimes exists as a fissure, extending the length of the lower half of the muscle; on other occasions the fissure is so long as to divide the muscle completely into two.

elbow joint, strengthens the latter very much. Its lower part lies under the tendon of the biceps, and between the pronator teres and the supinator longus.[1]

The Triceps Extensor Cubiti, or Brachii,

Forms the whole of the fleshy mass on the back of the arm; it therefore occupies the space between the integuments and the bone. It arises by three heads. The first, called Longus, comes by a flattened tendon, between the teres major and minor muscles, from a rough ridge on the inferior edge of the cervix scapulæ. The second, called the Brevis, arises by a sharp, tendinous, and fleshy beginning, from a slight ridge on the outer back part of the os humeri, just below its head. The third head, called Brachialis Externus, arises, by an acute fleshy beginning from the inner side of the os humeri near the insertion of the teres major. This muscle, both at its external and internal edge, is separated from the muscles in front of the arm by the external and internal inter-muscular ligaments, which begin near the middle of the os humeri, and run to the condyles respectively. The whole back of the os humeri, and the posterior surface of these inter-muscular septa, are occupied by the origin of the triceps. The muscular fibres run in various directions, according to their respective heads and places of origin. At the inferior end of the muscle is found a broad tendon, which covers its posterior face. This tendon is inserted into the base or back part of the olecranon, and the ridge leading down the ulna on its radial side. The bellies of the triceps unite above the middle of the os humeri, but the interstices between them may be observed much lower down. There is a bursa between the tendon and the olecranon process; besides which, there is sometimes another on each side of the first.

The triceps extends the fore arm.

The Anconeus

Is a small triangular muscle, just beneath the skin, at the outer posterior part of the elbow joint. It arises tendinous from the posterior lower part of the external condyle of the os humeri, adheres to the capsular ligament of the joint, and is partly covered by the tendon of the triceps.

It is inserted, fleshy and thin, into the ridge leading from the olecranon, on the outer part of the upper end of the ulna, and into the triangular depression found there, so as to fill it up.

It extends the fore arm.

[1] Varieties. Sometimes at its external margin, there exists a smaller brachialis internus muscle, which arises from about the same point of the os humeri, and is inserted into the same part of the ulna. Sometimes it detaches a fasciculus which joins the biceps muscle. Sometimes its posterior part is distinct from the anterior. Sometimes a fasciculus of it runs along the supinator longus of the fore arm.

SECT. IV.—OF THE MUSCLES OF THE FORE ARM.

There are eight muscles on the front of the fore arm, some of which are superficial, and others deep-seated. They, for the most part, are either directly or indirectly flexors of the fore arm and hand, and in their origin adhere very much by the tendinous partitions, called Intermuscular Ligaments.

1. *The Pronator Radii Teres*

Is just beneath the fascia of the fore arm, and forms the radial side of the muscles of the internal condyle. It arises, fleshy, from the anterior face of the internal condyle of the os humeri, and tendinous from the coronoid process of the ulna. It passes very obliquely across the fore arm, at the internal edge of the brachialis internus muscle, and is inserted, tendinous and fleshy, into the external back part of the radius,

Fig. 130.

Superficial layer of the Muscles of the Fore arm.—1. The lower part of the biceps, with its tendon. 2. A part of the brachialis internus, seen beneath the biceps. 3. A part of the triceps. 4. The pronator radii teres. 5. The flexor carpi radialis. 6. The palmaris longus. 7. One of the fasciculi of the flexor sublimis digitorum; the rest of the muscle is seen beneath the tendons of the palmaris longus and flexor carpi radialis. 8. The flexor carpi ulnaris. 9. The palmar fascia. 10. The palmaris brevis muscle. 11. The abductor pollicis muscle. 12. One portion of the flexor brevis pollicis; the leading line crosses a part of the adductor pollicis. 13. The supinator longus muscle. 14. The extensor ossis metacarpi, and extensor primi internodii pollicis, curving around the lower border of the fore arm.

just below the insertion of the supinator radii brevis, so as to occupy about two inches of the middle of the bone.

It rolls the hand inwards.[1]

2. *The Flexor Manus, vel Carpi Radialis,*

Is placed at the ulnar side of the last muscle, and is also superficial. It arises, by a narrow tendon, from the lower front part of the internal condyle of the os humeri, fleshy from the inter-muscular ligaments, the ante-brachial fascia, and from the upper part of the ulna. It forms a thick fleshy belly, terminating below in a tendon, which passes under the anterior annular ligament of the wrist, in a canal of its own, formed over the outer end of the scaphoid bone, and through the groove in the os trapezium.

It is inserted, tendinous, into the base of the metacarpal bone of the fore finger, in front, having to bend over deeply to get there.

There is a bursa between the lower extremity of its tendon and the trapezium; the tendon is there held down by ligamentous fibres.

It bends the hand, and draws it towards the radius.

3. *The Palmaris Longus*

Is at the ulnar side of the flexor carpi radialis, and is superficial. It is a small short muscle, terminating in a long slender tendon, and arises by a small tendon from the internal condyle, and fleshy from the inter-muscular ligament on each of its sides.

It is inserted, tendinous, into the anterior face of the ligamentum carpi annulare anterius, near the root of the thumb; and a division of its tendon passes on to the aponeurosis palmaris. Its tendon escapes about half way down the fore arm, from confinement beneath the ante-brachial fascia. Hence it springs up in the contraction of the muscle.

It bends the hand, and makes tense the palmar aponeurosis.[2]

4. *The Flexor Manus, vel Carpi Ulnaris,*

Occupies, among the superficial muscles, the ulnar side of the fore arm. It arises, tendinous, from the internal condyle of the os humeri, fleshy from the upper internal side of the olecranon, and by a tendinous expansion, being a part of the fascia of the fore arm, from the ridge at the internal side of the ulna, to within three or four inches of the wrist.

It is inserted into the upper side of the os pisiforme by a round tendon, which arises early at the radial margin of the muscle, and receives the muscular fibres. The tendon is continued from the os pisiforme, so as to be likewise inserted into the unciform process of the unciforme and into the base of the metacarpal bone of the little finger. There is a loose bursa at the junction of the tendon with the pisiforme.

It bends the hand, and draws it towards the ulna.

[1] Varieties. Sometimes it is double.

[2] Varieties. Sometimes it is deficient in both arms; sometimes the middle part only is fleshy; sometimes the belly goes almost to the wrist.

5. *The Flexor Digitorum Sublimis Perforatus*

Is concealed very much by the muscles just enumerated, in consequence of being placed between them. To get a good view of its origin, they all should be cut away from the os humeri. It arises, tendinous and fleshy, from the internal condyle of the os humeri, tendinous from the coronoid process of the ulna, and fleshy from the tubercle of the radius; the latter part of its origin being extended, tendinous obliquely, for three or four inches from that line of the radius which is at the insertion of the supinator radii brevis. With these origins, the muscle spreads over the front of the fore arm at its upper part, from the radial to the ulnar margin.

Four distinct tendons arise from the lower end of the muscle, which commence much above the wrist, pass beneath its anterior ligament, and, having reached the palm of the hand, diverge to the several fingers. A tendon is appropriated to each finger, and passes in front of its metacarpal bone to the phalanges, being inserted after having split into two, into the angle formed on each side by the junction of the cylindrical and flat surface of the second phalanx near its middle.

It bends the second phalanges on the first; its action may also be continued so as to clench the hand and to bend it on the fore arm.[1]

6. *The Flexor Digitorum Profundus Perforans*

Is beneath the flexor sublimis and the flexor ulnaris. It arises, fleshy, from the oblong concavity of the ulna, along the inner side of the coronoid and of the olecranon process, fleshy from the lower margin of the base of the coronoid process, from the ulnar portion of the interosseous ligament, and from the front of the upper two-thirds of the ulna.

Fig. 131.

The Metacarpal and Phalangial Bones of two fingers, with the tendons. In the first figure the tendons of the flexor muscle are bound to the finger by the fibrous bands; in the second they are freed from that structure, as well as from the synovial membrane and the vincula accessoria. 1. Metacarpal bone. 2. Tendon of flexor sublimis. 3. Tendon of flexor profundus. * The perforation of the former by the latter. 4. Tendon of extensor digitorum communis. 5. A lumbricalis muscle. 6. An interosseous muscle.

[1] Varieties. The tendon to the little finger is sometimes wanting, in which case the deficiency is supplied by the tendon of the flexor profundus. Sometimes the section of this muscle which belongs to the fore finger is insulated from the rest of it by a long fissure, and, moreover, divided by a middle tendon into two fleshy portions.

The tendons of this muscle are different from those of the other; they commence in front of it, like a tendinous membrane, which is gradually divided into several fasciculi, adhering to each other by cellular membrane. The fasciculated character of the tendons is still preserved when they go under the anterior carpal ligament, and until they begin to disperse as distinct tendons to each of the fingers.

Each tendon, going in front of its metacarpal bone and of the corresponding phalanges, gets through the slit in the flexor sublimis, and is inserted into the front part of the root of the third phalanx of its respective finger.

It bends the last phalanges of the fingers, and may, by increased action, flex the hand like the preceding muscle.[1]

7. *The Flexor Longus Pollicis*

Lies in front of the radius, but beneath the flexor sublimis. It arises by an acute fleshy beginning, from the radius just below its tubercle; also fleshy from the middle two-thirds of the front of this bone, and from the radial portion of the interosseous ligament. The body of the muscle is joined by a small fleshy slip, having a tendinous origin from the internal condyle of the os humeri.

A tendon is formed early on the ulnar margin of this muscle, and to which the fibres pass obliquely. The tendon goes under the annular ligament of the wrist, through the fossa formed in the short flexor muscle of the thumb, and between the sesamoid bones, to be inserted into the base of the second phalanx of the thumb.

From the inferior end of the fore arm to the middle of the first phalanx, the tendon is invested by its appropriate bursa.

It bends the last joint of the thumb.[2]

The several flexor tendons, as they pass under the anterior annular ligament of the wrist, are surrounded by the superior Bursa Mucosa. It begins about an inch and a half above the radio-carpal articulation, and extends to the lower margin of the annular ligament. It adheres by its circumference to this ligament and to the capsule of the joint; within, it sends in a considerable number of processes, whereby each tendon is surrounded, and connected to the adjoining tendons; while at the same time no restraint is put upon the natural motions of the part. In its texture this bursa resembles a dense and elastic cellular membrane.

In addition to this, the flexor tendons, as they pass from the root to the extremity of each finger, are surrounded by a synovial bursa; which by its secretion continually lubricates them, and permits them to play freely backwards and forwards, according to the flexions and extensions of the fingers. These mucous or synovial sheaths begin a little distance above the first joint of the finger, adhere there to both flexor

[1] Varieties. Sometimes a distinct fasciculus comes from the internal condyle to join it; sometimes a fasciculus comes from the flexor longus pollicis, and terminating in a tendinous expansion, is inserted into the tendons which the flexor profundus sends to the fore finger.

[2] The last two muscles adhere only to inconsiderable extent to the interosseous ligament, for the more central portion of the latter is comparatively free.

tendons, and extend to about the middle of the last phalanx. They give to the tendons a very polished lubricated surface; are reflected over the anterior flat faces of the phalanges, being separated partially from them by a small quantity of adipose matter: they are also reflected over the anterior faces of the capsular ligaments, and line the vaginal ligaments.

The Vaginal Ligaments of the fingers (*ligamenta vaginalia*) bind down the flexor tendons, and keep them applied to the fronts of the phalanges. They are of the same extent from above downwards, with the mucous sheaths just mentioned, and are stretched between the ulnar and the radial margins of the phalanges. The fibres of which they consist pass for the most part transversely, and are of a fibro-cartilaginous character. These fibres diminish in number towards the end of each finger, and are stronger on the fore finger than on any of the others. In front of the first joints or the metacarpo-phalangial articulations, and the phalangial articulations, the vaginal ligaments are much thinner than elsewhere, in order to permit the free flexion of the fingers. The structure, indeed, at these points is decidedly marked off by its diminished thickness, and though the course of the fibres is the same from side to side, yet some anatomists have thought it worth while to designate it particularly under the name of Annuli Juncturarum Ligamentosi.

Within the vaginal ligaments small fræna arise from the first and second phalanges; they vary in number in different individuals, and run obliquely forwards, some to terminate in the flexor profundus tendons, and others in those of the flexor sublimis; they are called Vincula Accessoria, and are covered by a reflection of the synovial sheath. Indeed, they seem to be formed almost entirely from the latter.

8. *The Pronator Quadratus*

Is just above the carpal surfaces of the radius and ulna, and between the other muscles and the bone. In the adult it is about two inches wide, and its fibres run across the fore arm. It arises, fleshy and tendinous, from the ridge at the inner surface of the ulna, near its lower extremity, and from the front of the bone.

It is inserted into the corresponding front surface of the radius.

It rotates the radius inwards.[1]

Of the Muscles on the back of the Fore Arm.

These muscles are ten in number. They arise, for the most part, from the external condyle, or the ridge leading to it, and are extensors either of the fore arm, or of the fingers and thumb. Their origins are less blended with each other than those of the flexor muscles; nevertheless, between several of them there are inter-muscular ligaments which connect them. They are superficial and deep-seated.

[1] Varieties. This muscle in some very rare cases does not exist. Sometimes it consists in two layers whose fibres cross each other. In a case noticed in the Pennsylvania Hospital by Dr. J. R. Barton, it consisted in two triangular pieces, the bases of which were reversed.

1. *The Supinator Radii Longus*

Is situated along the radial edge of the fore arm, immediately beneath the integuments. It arises, fleshy and tendinous, from the higher part of the ridge leading to the external condyle; commencing just below the insertion of the deltoid muscle, and being here placed between the brachialis internus and the outer head of the triceps. It forms a thick fleshy belly, constituting the external margin of the arm, about the elbow joint; and terminates about the middle of the radius in a flat tendon.

It is inserted, by the tendon, into a small, rough ridge, on the outer side of the radius just above its styloid process.

It rolls the radius outwards.

Fig. 132.

The superficial layer of Muscles of the posterior aspect of the Fore Arm. 1. The lower part of the biceps. 2. Part of the brachialis internus. 3. The lower part of the triceps, inserted into the olecranon. 4. The supinator longus. 5. The extensor carpi radialis longior. 6. The extensor carpi radialis brevior. 7. The tendons of insertion of these two muscles. 8. The extensor communis digitorum. 9. Musculus auricularis. 10. The extensor carpi ulnaris. 11. The anconeus. 12. Part of the flexor carpi ulnaris. 13. The extensor ossis metacarpi and extensor primi internodii muscle, lying together. 14. The extensor secundi internodii; its tendon is seen crossing the two tendons of the extensor carpi radialis longior and brevior. 15. The posterior annular ligament. The tendons of the common extensor are seen upon the back of the hand, and their mode of distribution on the dorsum of the fingers.

2. *The Extensor Carpi Radialis Longior*

Is situated beneath the former muscle. It arises tendinous and fleshy, from the space of the external ridge of the os humeri, between

the supinator longus and the external condyle. It forms a short, fleshy belly, which terminates in a flat tendon above the middle of the adius.

It is inserted, by this tendon, into the posterior part of the root of the metacarpal bone of the fore finger, near the thumb.

The tendon of this muscle is surrounded by a synovial sheath, at the place where it passes the lower end of the radius, under the posterior carpal ligament. Another bursa exists, also, at its insertion; which, on one occasion, I found so much enlarged in a young woman, as to require its extirpation; the operation was fully successful.

It extends the hand.[1]

3. *The Extensor Carpi Radialis Brevior*

Is beneath the last, but projects somewhat beyond it. It arises, tendinous, from the posterior and lower part of the external condyle, and from the external lateral ligament of the elbow joint. It forms a thick, fleshy belly, placed along the radius, and terminates in a flat tendon about the middle of that bone.

Its tendon, becoming rounded, is inserted into the posterior part of the base of the metacarpal bone of the second finger, and has a bursa beneath its insertion, and another at the wrist.

It extends the hand.[2]

4. *The Extensor Carpi Ulnaris*

Is superficial, and placed principally parallel with the ulna. It arises, tendinous, from the external condyle, fleshy from the inter-muscular ligament, and the interior of the ante-brachial fascia as it is attached along the ulna. Crossing very obliquely the upper part of the radius and the ulna, it also arises fleshy from the back part of the latter bone. Its fibres terminate obliquely in a tendon which goes through the groove of the ulna, and is there furnished with a bursa.

It is inserted, by its tendon, into the ulnar side of the base of the metacarpal bone of the little finger.

It extends the hand.[3]

5. *The Extensor Digitorum Communis*

Is superficial, being placed beneath the extensor ulnaris and the extensor radialis brevior. It arises, tendinous, from the external condyle, and fleshy from the inter-muscular ligament of the contiguous muscles. As it approaches the wrist, it sends off four tendons, which pass together through a common groove on the back of the radius.

[1] Varieties. Sometimes a small fasciculus is detached from its posterior margin, and has a tendinous insertion into the third metacarpal bone.

[2] Varieties. Sometimes this muscle is so blended with the preceding as to be in common with it.

[3] Varieties. Sometimes its tendon is joined, by a small fasciculus, to the extensor tendon of the little finger.

On the back of the hand these tendons diverge, and near the roots of the fingers are connected by cross slips to each other.

Each tendon goes to its respective finger, and covers the whole posterior part of it, being spread out into a membrane which adheres to the phalanges, from the root of the first to the root of the last. The precise mode of the insertion of these tendons is as follows: on the back of the first phalanx, the lateral margins of these tendons are joined by the tendons of the lumbricales and interossei; and the tendinous membrane, thus formed, simply adheres by condensed cellular membrane to the whole back of the first phalanx; the middle part of this tendon then passes on to be inserted near the articular margin of the base of the second phalanx; and the two lateral parts of the tendinous membrane, after keeping separate for some distance, unite, and are jointly inserted into the back of the base of the third phalanx.

The division of this muscle appropriated to the little finger has a distinct appearance, and frequently its tendon goes through a separate fossa in the radius, or rather in the posterior carpal ligament, from which causes it has obtained the name of Musculus Auricularis. A bursa invests these tendons at the wrist as they pass through their groove, and is single above; but, in following the course of the tendons, like them it divides and follows each tendon respectively to the base of the first phalanx.

This muscle extends all the joints of the fingers, being the antagonist of the flexors.[1]

6. *The Supinator Radii Brevis*

Can only be well seen by detaching the origin of the aforesaid muscles; it will then be found in contact with the radius, making a close investment of its head and upper third. It arises, tendinous, from the external condyle of the os humeri, tendinous and fleshy from the ridge on the posterior radial edge of the ulna which descends from its coronoid process.

Its fibres surround, obliquely, the upper external part of the radius, and are inserted into its tubercle, and into its oblique rough ridge, corresponding with the upper margin of the pronator teres. At the interstice between the radius and ulna, near the anterior edge of this muscle, a fleshy slip is occasionally seen, which passes from the radial side of the coronoid process to the ulnar edge of the radius.

This muscle rotates the radius outwards.[2]

7. *The Extensor Ossis Metacarpi Pollicis Manus*

Arises, fleshy, from the posterior part of the ulna immediately below the anconeus, from the interosseous ligament, and from the back part of the radius just below the insertion of the supinator brevis. It ter-

[1] Varieties. It sometimes sends a double tendon to the little finger, in which case the auricularis is more distinct than usual, and the tendon next to the ulna runs through a distinct trochlea in the posterior carpal ligament.

[2] Varieties. Sometimes the superior part is separated from the inferior; sometimes the muscle is double.

minates in a rounded tendon which passes over the tendons of the radial extensors, and through a groove on the styloid side of the lower end of the radius. The tendon is there invested by a bursa.

It is inserted, by its tendon, into the base of the metacarpal bone of the thumb, and into the external side of the trapezium.

It extends the metacarpal bone of the thumb.[1]

8. *The Extensor Minor, or Primi Internodii Pollicis Manus,*

Is at the ulnar side of the last muscle. It arises, fleshy, from the back of the radius below its middle, and from the interosseous ligament. Sometimes tendinous, also, from the ulna. It terminates in a tendon which passes through the groove in the styloid side of the radius, along with the last-named muscle.

It is inserted into the first phalanx of the thumb, by its tendon, which is extended to the root of the second phalanx.

It extends the first phalanx.[2]

9. *The Extensor Major, or Secundi Internodii Pollicis Manus,*

Arises, by a small tendinous, and an extensive fleshy origin, from the back of the ulna above its middle, and from the interosseous ligament, also from the back of the radius; it terminates near the wrist in a tendon which passes through the groove on the back of the radius near the ulna. The belly of this muscle conceals, very much, the other extensors of the thumb.

It is inserted, by its tendon, into the oblong transverse tubercle, on the back of the base of the second phalanx of the thumb. Its tendon is furnished with one synovial sheath, at the inferior extremity of the radius, which extends to the carpus; and another which is smaller, and is placed upon the carpus and upon the base of the first metacarpal bone.

It extends the second phalanx.[3]

The tendons of the last two muscles are much connected with each other, and are spread in the form of a membrane on the back of the thumb, after the manner of the extensor tendons of the fingers. The minor is generally a much smaller muscle than the major.

10. *The Indicator*

Is a small muscle on the back of the ulna, concealed by the extensor communis and extensor ulnaris. It arises tendinous and fleshy, from the back of the ulna, commencing near its middle, and from the contiguous part of the interosseous ligament. It terminates in a tendon which goes through the same fossa with the extensor communis;

[1] Varieties. This muscle is sometimes double, and has several other modifications which it is unnecessary to state.

[2] Varieties. This muscle is sometimes only an appendage of the preceding. Occasionally, its tendon is confounded with that of the succeeding muscle.

[3] Varieties. Sometimes this muscle is completely double.

it afterwards is joined about the base of the first phalanx to the tendon of the common extensor belonging to the fore finger.

With the tendon of the extensor communis, it is inserted along the back of the fore finger as far as the base of the third phalanx.

It extends the fore finger.[1]

SECT. V.—OF THE MUSCLES OF THE HAND.

The Palmaris Brevis

Is just below the skin, at the inner side of the palm of the hand. It consists of separate fasciculi unequally divided, and arises from the anterior ligament of the wrist, and from the ulnar side of the palmar aponeurosis.

It is inserted into the skin and fat at the inner margin of the hand, and covers the muscles of the little finger.

It contracts the skin of the hand.

Beneath the Aponeurosis Palmaris are placed the long flexor tendons, and many of the small muscles of the hand.

The Lumbricales

Are conspicuous; they are four in number, of the size and shape of earth worms. They arise, tendinous and fleshy, from the radial sides of the tendons of the flexor profundus, beneath the ligamentum carpi annulare anterius, and a little beyond its inferior edge.

They terminate in little flat tendons, which run along the outer or radial edge of the fingers, and are inserted respectively into the tendinous expansion of the extensor communis on the back of the first phalanx of each finger, about its middle.

They bend the first phalanges.[2]

Four muscles constitute the ball of the thumb.

1. *The Abductor Pollicis Manus*

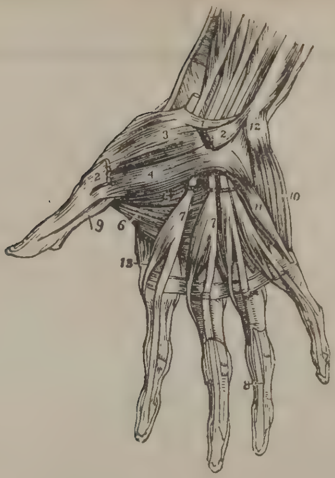
Arises, tendinous and fleshy, from the anterior surface of the anterior carpal ligament, and from the projecting ends of the trapezium and scaphoides.

It is inserted, tendinous, into the outer side of the base of the first phalanx of the thumb, and into the tendinous membrane derived from the extensors on its back part.

[1] Varieties. This muscle is subject to many modifications; sometimes it is digastric; sometimes it is double, and the second head goes to the middle finger. In the latter case anatomists have recognized a disposition similar to that of the short extensors of the toes, and also an arrangement corresponding with what occurs in some species of the ape. Another example of the truth of the rule that the most of those varieties in the muscular system, commonly called anomalies, are only indications on the part of nature of the alliance between the structure of man and that of the lower orders of animals. In which point of view, they are both instructive and amusing, and are well deserving of attention.

[2] Varieties. Sometimes one is deficient; sometimes one or more is double, in which case the supernumerary goes to the ulnar edge of the adjoining finger.

Fig. 133.



The Muscles of the Hand. 1. The annular ligament. 2, 2. The origin and insertion of the abductor pollicis muscle; the middle portion has been removed. 3. The flexor ossis metacarpi, or opponens pollicis. 4. One portion of the flexor brevis pollicis. 5. The deep portion of the flexor brevis pollicis. 6. The adductor pollicis. 7, 7. The lumbricales muscles, arising from the deep flexor tendons, upon which the numbers are placed. The tendons of the flexor sublimis have been removed from the palm of the hand. 8. One of the tendons of the deep flexor, passing between the two terminal slips of the tendon of the flexor sublimis, to reach the last phalanx. 9. The tendon of the flexor longus pollicis, passing between the two portions of the flexor brevis to the last phalanx. 10. The abductor minimi digiti. 11. The flexor brevis minimi digiti. The edge of the flexor ossis metacarpi, or adductor minimi digiti, is seen projecting beyond the inner border of the flexor brevis. 12. The prominence of the pisiform bone. 13. The first dorsal interosseous muscle, or the abductor indicis.

It draws the thumb from the fore finger. This muscle is next to the skin.

2. *The Opponens Pollicis*

Is beneath the abductor, and without its removal can scarcely be seen. It arises, tendinous and fleshy, from the projecting point of the os trapezium, and from the adjacent part of the anterior carpal ligament.

It is inserted, tendinous and fleshy, into the radial edge of the metacarpal bone of the thumb, from its base to its head.

It draws the metacarpal bone inwards.

3. *The Flexor Brevis Pollicis Manus*

Is beneath the abductor pollicis, and at the side of the opponens pollicis. A groove is formed in it by the tendon of the flexor longus pollicis, which divides it into two heads.

The first head arises, fleshy, from the point of the trapezium, trapezoides, and from the contiguous part of the internal surface of the anterior annular ligament, and is inserted into the outer sesamoid bone; the sesamoid bone, like a patella, being connected to the first phalanx of the thumb by a tendon.

The second or internal head arises, fleshy, from the magnum and unciforme, near their metacarpal surfaces, and from the base of the

metacarpal bone of the middle finger. It is inserted into the inner sesamoid bone, which, like the external, is connected by ligament to the first phalanx.

The short flexor, as its name implies, bends the first phalanx of the thumb.

4. *The Adductor Pollicis Manus*

Lies in the palm of the hand, beneath the lumbricales and the tendons of the flexor sublimis and profundus. It arises, fleshy, from the ulnar edge of the metacarpal bone of the middle finger, between its base and head, and it is inserted, tendinous, into the inner part of the base of the first phalanx of the thumb, just beyond the sesamoid bone.

It pulls the thumb towards the fingers.

The Abductor Indicis Manus

Is on the radial edge of the hand, between the metacarpal bone of the fore-finger and thumb, and is just beneath the skin. It arises tendinous from the trapezium, and fleshy from the ulnar edge of the metacarpal bone of the thumb, between its base and head.

Being placed along the side of the metacarpal bone of the fore finger, it is inserted, by a short tendon, into the radial side of the first phalanx, in company with the prior indicis. This muscle, in connection with the prior indicis, is the first dorsal interosseal of some writers.

It draws the fore finger from the others.

There are three muscles constituting the ball of the ulnar side of the hand, or of the little finger.

1. *The Abductor Minimi Digiti Manus*

Is the most superficial. It arises, fleshy, from the protuberance on the internal side of the os pisiforme, and from the contiguous part of the annular ligament.

It is inserted, tendinous, into the ulnar side of the first phalanx of the little finger, and into the tendinous membrane which covers its back part.

It draws the little finger from the rest.

2. *The Flexor Parvus Minimi Digiti Manus*

Is beneath the abductor. It arises, fleshy, from the unciform process of the os unciforme, and from the contiguous part of the anterior annular ligament.

It is inserted, tendinous, into the ulnar side of the base of the first phalanx of the little finger, being united with the tendon of the abductor, and with the tendinous membrane expanded over the back of the finger.

It bends the little finger.[1]

[1] Varieties. Sometimes it is wanting, in which case the preceding is more developed than usual.

3. *The Adductor Metacarpi Minimi Digiti*

Is placed beneath the abductor and flexor, next to the metacarpal bone. It arises, fleshy, from the unciform process of the os unciforme; and from the contiguous part of the annular ligament of the wrist.

It is inserted, tendinous and fleshy, into the fore part of the metacarpal bone of the little finger, from its base to its head.

It brings the metacarpal bone of the little finger towards the wrist, and thereby deepens the hollow of the hand.

The Interosseous Muscles fill up the interstices of the metacarpal bones; they are seven in number, four on the palm, and three on the back of the hand. The back ones arise by double heads from the contiguous sides of two metacarpal bones; the palmar ones have a single head, which comes only from the metacarpal bone of the finger, which the interosseous muscle is intended to serve. As a general description, they all may be said to arise, fleshy and tendinous, from the bases and sides of the metacarpal bones, and to be inserted, tendinous, into the sides of the first phalanges, and into the tendinous membrane on the backs of the fingers, derived from the tendons of the extensor communis. The first four must be looked for on the palm, the three others on the back of the hand.

1. *The Prior Indicis*

Is along the radial side of the first digital metacarpal bone, and arises from the base and side of the same.

It is inserted, tendinous, into the radial side of the first phalanx of the fore finger.

It draws the fore finger towards the thumb.

The abductor indicis and this muscle are very closely united at their insertion. This circumstance, together with their analogy with the first dorsal interosseal of the foot, has induced many anatomists to identify them as a common muscle. It simplifies the description, and has that to recommend it; the actual division, however, is so well marked, much more strongly than that in many other muscles admitted to be absolutely distinct, that it may be well doubted, taking in view this circumstance, and the strong action of the abductor on the fore finger, whether effective and useful description is not thus sacrificed; and whether it would not be better to divide the first dorsal interosseal of the foot, for the sake of the analogy, if it is to be secured, than to merge a certainly distinct muscle in mere classification and analogy. The hand is the member in precedence from its various functions, but if it yield to the foot in this instance, there are others also equally, if not more, urgent.

2. *The Posterior Indicis*

Is at the ulnar side of the first digital metacarpal bone. It arises from the base and ulnar side of the same bone, and is inserted tendinous into the ulnar side of the first phalanx of the fore finger.

It draws the fore finger towards the others.

3. *The Prior Annularis*

Is at the radial side of the metacarpal bone of the third or ring finger. It arises from the base and radial side of the said bone.

It is inserted, tendinous, into the radial side of the first phalanx of the ring finger.

It draws that finger towards the thumb.

4. *The Interosseus Auricularis*

Is at the radial side of the metacarpal bone of the little finger, and arises from the radial side and base of said bone.

It is inserted, tendinous, into the radial side of the first phalanx of the same finger.

It draws the little finger towards the other.

By removing the tendons of the extensor communis from the back of the hand, we see the three posterior or double-headed interosseous muscles.

5. *The Prior Medii*

Is between the metacarpal bone of the fore and of the middle finger. It arises from the opposed roots and sides of these bones.

It is inserted, tendinous, into the radial side of the first phalanx of the middle finger.

It draws the middle finger towards the thumb.

6. *The Posterior Medii*

Is between the metacarpal bone of the middle and of the ring finger. It arises from the opposite sides and roots of these bones.

It is inserted, tendinous, into the ulnar side of the first phalanx of the middle finger.

It draws the middle towards the little finger.

7. *The Posterior Annularis*

Is between the metacarpal bones of the ring and little finger. It arises from the opposed sides and roots of these metacarpal bones.

It is inserted, tendinous, into the ulnar side of the first phalanx of the ring finger.

It draws the ring towards the little finger.

CHAPTER IV.

OF THE FASCIÆ AND MUSCLES OF THE LOWER EXTREMITIES.

SECT. I.—OF THE FASCIÆ.

THE muscles of the lower extremity, from the pelvis to the foot inclusively, are invested by a strong aponeurotic membrane, placed immediately beneath the skin or common integuments. Its external face is in contact with the superficial nerves and blood-vessels, and the internal face with the muscles. Though it is absolutely continuous from one end to the other, it will be useful, for study, to divide it into several parts; one covering the Hip; another the Thigh; another the Leg, and the fourth covering the Foot; each of them presents certain points of arrangement which could not be very conveniently introduced into a general description.

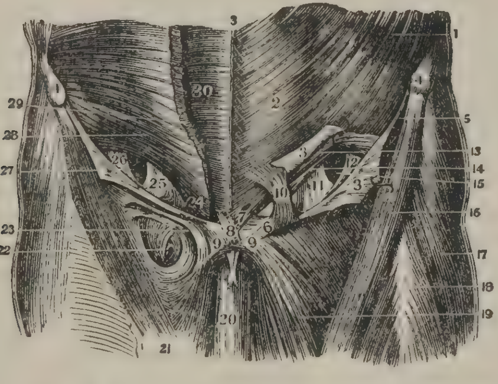
The Fascia Ischiadica, or Fascia of the Hip.—The aponeurosis begins posteriorly, from the upper part of the gluteus magnus muscle, by a very gradual conversion of the cellular membrane of the part into desmoid substance; it also begins in the way of cellular substance from the margin of the sacrum and os coccygis. The character here is seldom entirely aponeurotic till it gets on a level with the tendon of the gluteus magnus, from which emanate a great many of its fibres. Externally, it arises from the whole length of the crista of the ilium, is there strikingly aponeurotic, and is closely adherent to the gluteus medius muscle, many of whose fibres arise from it. It also arises from the body and rami of the pubes, and from the tuber and ramus of the ischium. Its attachment at the latter is not very strong, nor is its character so well marked. It is there, in some measure, continuous with the perineal fascia. In front, it adheres very closely to the inferior margin of the tendon of the external oblique muscle, so as to be almost continuous with it, from the anterior superior spinous process of the ilium to the pubes; and is continued uninterruptedly into the iliac fascia, so that it covers the iliacus internus and psoas magnus muscles, by that extension. The division attached to the pelvis, and surrounding it, may be called the *Fascia Ischiadica*, or fascia of the Hip.

The Fascia Femoris.—From these several connections at the pelvis, the fascia descends in enveloping the muscles of the thigh, and then forms other strong attachments about the knee, to the condyles of the os femoris and to the head of the tibia. In front, it adheres very closely to, and is almost blended into the common tendon of the extensor muscles; it adheres, also, to the inferior margins of the two vasti, and is one and the same with the membranous expansion (*involucrum*) going from them to the head of the tibia, and answering the purpose of capsular ligament to the articulation of the knee, on each side of the patella, as far back as the lateral ligaments. Behind, it covers up the fat in the ham, and is continued into the fascia of the leg.

The fascia femoris, almost everywhere, consists in a fibrous texture, which is sufficiently evident, but the fibres pass in very various directions. At many places, particularly on the internal side of the thigh, there are oblique fibres spread upon a lamina which is not fibrous. On the outside of the thigh, the fascia consists principally in longitudinal fibres, held together by transverse ones, and when its interior surface is examined, many oblique fibres are also found there. It is very thick and strong on the outer face of the thigh, thinner behind, and still weaker internally, where cellular substance seems to predominate in its composition. It is pierced at several points with small round holes for the passing of blood-vessels and of the cutaneous nerves.

From the interior surface of the Fascia Femoris, partitions pass off, which separate the muscles of the thigh from each other, and form sheaths for them. Some of these processes are merely cellular substance; others have a more distinct desmoid character. Externally, as it passes from the gluteus medius to the groin, it separates into two laminæ, which receive between them the tensor vaginæ femoris, and then reunite. The sartorius muscle, in almost its whole length, is also enclosed between two laminæ. At the origin of this muscle, the posterior lamina passes on to the iliacus internus, and psoas magnus muscles, and then to the pectineus, to become the Pectineal Fascia, in all of which distance it is continuous with the iliac fascia of the pelvis; but the anterior lamina of the fascia at this place, being the Sartorial Fascia, has its upper margin continuous with Poupart's ligament; and this lamina terminates in a point or angle, which is turned inward to

Fig. 134.



A view of the Abdominal Muscles and the Abdominal or Inguinal Canal. 1. External oblique muscle of the abdomen. 2. Its aponeurosis. 3. Its tendon slit up and turned back to show the canal. 4. Anterior superior spinous process. 5. Upper portion of Poupart's ligament. 6. External column of the external ring. 7. Internal column of the external ring. 8. Intercrossing of the tendons of each side. 9 Body of the pubes. 10. Upper boundary of the external abdominal ring—the line points to the ring. 11, 12. Fascia transversalis. 13. Fibres of the internal oblique turned up. 14. Fibres of the transversalis muscle. 15. Points to the internal ring, the opening is enlarged for the demonstration. 16. Sartorius. 17. Fascia lata femoris. 18. Rectus femoris. 19. Adductor longus. 20 Penis. 21. Fascia lata of the opposite thigh. 22. Point where the saphena vein enters the femoral. 23. Fascia lata as applied to the vessels. 24. Insertion of the transversalis muscle on the pubis. 25, 26. Correspond to 11, 12, of the opposite side and indicate the fascia transversalis. 27. Poupart's ligament turned off from the internal muscles. 28. Transversalis abdominis. 29. Internal oblique. 30. Rectus abdominis.

the crista of the pubes, and ends by an insertion into it immediately exterior to Gimbernat's ligament, and in the same line with it. This point, from the part which it acts in femoral hernia, has been studied with particular attention, and goes under the name of Hey's, or the Femoral Ligament.

The pectineal fascia is placed behind the femoral vessels, but the sartorial fascia is before them.[1] The latter terminates on its pubic side, in a crescentic or lunated edge, of one and a-half or two inches in length, the concavity of which is towards the penis.[2] Hey's ligament is the superior extremity of the crescent; the inferior end can scarcely be considered to have a definite boundary, but is continuous with the adjacent part of the pectineal fascia. The place of continuity is covered by the saphena vein, which being between the skin and the fascia lata, dips there into the femoral vein, which is under the crescentic edge. The femoral vessels reposing in their sheaths, are then placed between these laminæ of the fascia femoris. The vein is only partially covered by the lunated edge, while the artery, which is on the iliac side of the vein, is completely concealed. By keeping the leg extended, and turning the toes of the subject inwards or outwards, it will be seen that the crescentic edge and the tendon of the external oblique exercise a mutual tension. Beneath Poupart's ligament, at the inner margin of the femoral vein, is the hole called the Femoral Ring, through which the bowel escapes in femoral hernia. This hole is constricted by turning the toes outwards, and relaxed by turning them inwards; it becomes very much relaxed, if, at the same time, the thigh be drawn upwards. Valuable indications for the mode of replacing a prolapsed bowel are thus obtained.

In addition to this arrangement, which is all-important in hernia, the fascia femoris has the following. On the front of the thigh it simply covers the extensor muscles, the partitions between which are areolar substance. On the inner side it dips down to the periosteum between the adductor muscles, but is still cellular. Behind, it covers the ham-string muscles, and sends down to the linea aspera a thick fibrous partition between the vastus externus and the biceps flexor.

The superior margin of the gluteus magnus is inserted into this fascia, which from its connection with the gluteus medius and tensor vaginæ femoris, causes all these muscles to exercise a mutual influence, as well as to keep tense the fascia itself. On the internal semi-circumference of the thigh it adheres somewhat closely to the muscles; but on the external, where the fascia is opposed to the tendinous facing of the vastus externus muscle, it is connected by a long, loose, and scattered cellular substance, which scarcely presents an obstacle to the introduction of the finger or any blunt instrument, between the two.

The *Fascia Cruralis*, or that of the Leg, though absolutely continuous with that of the thigh, may be described as arising externally

[1] By sartorial fascia is merely meant the portion of the fascia lata femoris contiguous to the sartorius muscle; and, by pectineal fascia, the part covering the pectineus muscle.

[2] The crescentic edge is not always well defined, for in many cases it is blended insensibly with the sheath of the blood-vessels, so that a defined exhibition of it is rather the result of artificial separation or dissection, than a natural condition.

from the head of the fibula and from a prolongation of the biceps flexor cruris; internally from prolongations of the tendon of the sartorius, the gracilis, and the semi-tendinosus. It, in descending, covers all the superficial muscles of the leg, does not go over the tibia, but adheres to its spine and to its internal angle. It unites below to the annular ligament of the ankle, to the ligamentous sheath of the peroneal muscles, and to that on the inner ankle.

The fascia cruralis, in the superior half of the leg, assists in giving origin to its muscles in front and externally, but is rather loosely attached to them below. On the back of the leg it is also rather loosely connected to the gastrocnemii. It sends in one aponeurotic partition between the common extensor of the toes and the long peroneus, and another between the latter and the soleus, both of which are inserted into the fibula. It also is insinuated between the soleus and the muscles next to the bones. This prolongation is strong and fibrous, penetrates between these muscles, dips down to the tibia and fibula, and is lost insensibly just below the fascia of the popliteus muscle. The popliteal fascia may also be considered one of the emanations from the fascia cruralis.

The fascia cruralis is not so strong as the femoral, yet it has the same compact desmoid texture, and is formed from fibres crossing in various directions. It is thicker in front than behind, and is made tense by its connection with the internal and external ham-string muscles.

Of the Ligamentum Annulare of the Ankle Joint.

The muscles on the front of the leg have their tendons confined at the ankle by this ligament, which may be very properly associated with the description of the crural fascia, owing to the closeness of the connection of the two. It consists in a fasciculus of ligamentous fibres running across the front of the ankle joint. It is attached by one extremity to the superior face of the greater apophysis of the os calcis, just before the malleolus externus; is there very strikingly fibrous or ligamentous, and has its small fasciculi separated by fatty matter. It is then directed inwards, and divides into two laminæ, one of which goes above the tendons, and the other below them. These laminæ, by keeping to their respective sides of the tendons, form a loose gutter for each of them to play in; the gutters, however, for the tibialis anticus and extensor proprius pollicis are not so perfect as that for the extensor communis, being, in fact, largely defective in front, and they are also more loose. The ligament is then fixed by one division, the upper, to the anterior margin of the malleolus internus: this division goes behind the tendon of the extensor proprius pollicis and that of the tibialis anticus. The other portion being in front of them and nearer to the foot, is wrapped over its internal face and inserted into the scaphoides and the internal margin of the fascia plantaris. As the upper margin of this ligament is continuous with the fascia cruralis, so the inferior runs into the fascia on the back of the foot, called Aponeurosis Dorsalis Pedis.

Fascia Pedis, or Aponeurosis of the Foot.—The fascia cruralis being strongly attached to the posterior and lower margins of the internal ankle, its fibres radiate thence to the lower part of the tendo-Achillis, to the inner side of the os calcis, and to the internal margin of the fascia plantaris. This is the Ligamentum Laciniatum (or plaited ligament) of writers, and conceals the tendons which pass to the sole of the foot, along the sinuosity of the os calcis.

The Aponeurosis Dorsalis Pedis is continued from the annular ligament, over the upper surface of the foot, to the roots of the toes. It is thin, but its fibrous texture is apparent. It is spread over the extensor tendons of the toes and the extensor brevis muscle, and is slightly attached along the internal and the external margin of the foot.

The Aponeurosis Plantaris is on the sole of the foot, between its common integuments and the muscles. It is attached behind to the tuberosities of the os calcis, and is quickly divided into three portions, which are kept distinct by well-marked depressions between them. The internal portion lies upon the muscles at the inner side of the foot, the external portion upon the muscles at the outer side, and the middle covers longitudinally the central parts of the sole. The first two portions are thin, reticulated, and extended respectively to the root of the outer and of the inner metatarsal bone, and along the margin of the foot, where they join the fascia or aponeurosis dorsalis. The middle portion increases in breadth as it advances, and at the anterior extremity of the metatarsus is divided into five slips, one for each metatarsal bone. The lumbricales, the vessels, and the nerves, pass to their toes, respectively, between these primary divisions. Each of these slips is subdivided into two, which penetrate upwards, and fix themselves to their respective side of the head of the corresponding metatarsal bone. In the interval left by this bifurcation, the flexor tendons pass to the toe.

The plantar aponeurosis or fascia affords behind origin to the superficial muscles of the sole of the foot. It also sends in partitions between them. Its thickness is considerable behind, but continually diminishes as it advances forwards. Its fibrous texture is very well marked, and is much more compact near the heel, where it looks like ligament; the fibres run principally longitudinally. From its inferior surface many strong filaments pass to the skin on the sole of the foot, and contain within their interstices a granulated adeps.

The adipose matter is nearly half an inch thick on the heel; it cruises thence along the outer margin of the foot, as a thinner layer, and is again increased in thickness along the anterior ends of the metatarsal bones, being mixed up with the bifurcations and with the reticular arrangements there, of the plantar aponeurosis. On the hollow of the foot, as on that of the hand, the thickness of the cushion of fat is much reduced, the fascia plantaris being very near the skin.

SECT. II.—MUSCLES OF THE THIGH.

The Tensor Fasciæ, vel Vaginæ Femoris,

Is situated superficially on the anterior outer part of the hip. It arises, tendinous, from the anterior superior spinous process of the ilium; passes downwards and somewhat backwards between two laminæ of the fascia femoris, increasing in breadth as it descends, and is inserted fleshy into the fascia femoris, somewhat below the level of the trochanter major.

It rotates the foot inwards, and makes the fascia tense.

The Sartorius

Is placed superficially on the internal side of the thigh. It arises by a short tendon from the anterior superior spinous process of the ilium, and passes in a spiral course to the inner side of the thigh and to the back of the internal condyle. It then winds behind the head of the tibia, and advances forwards, so as to be inserted into the internal

Fig. 135.

A view of the Muscles on the Front of the Thigh. 1. Crest of the ilium. 2. Its anterior superior spinous process. 3. Gluteus medius. 4. Tensor vaginæ femoris. 5. Sartorius. 6. Rectus femoris. 7. Vastus externus. 8. Vastus internus. 9. Patella. 10. Iliacus internus. 11. Psoas magnus. 12. Pectineus. 13. Adductor longus. 14. Adductor magnus. 15. Gracilis.

side of the lower part of its tubercle, by a broad tendon. Its fibres run the whole length of the muscle.

Its tendon is continued by a flat slip from its lower margin, into the fascia cruralis, by which attachment the muscle is held in its spiral course. It crosses the rectus femoris and vastus internus, above the triceps adductor, at the middle of the thigh; and at the lower part of the latter, just above the knee, it is between the tendon of the adductor magnus and that of the gracilis.

It bends the leg and draws it obliquely inwards.[1]

The Rectus Femoris

Is in front of the thigh bone and just beneath the fascia femoris, with the exception of its origin, which is covered by the sartorius. It is a complete penniform muscle, fleshy in front, for the most part, but faced behind with tendon. It arises from the anterior inferior spinous process of the ilium, by a round tendon, which is joined by another tendon, coming from the superior margin of the acetabulum.

It is inserted into the superior surface of the patella by a strong tendon, and intermediately, by the ligamentum patellæ, into the tubercle of the tibia.

It extends the leg.

The Vastus Externus

Is a very large muscle on the outside of the thigh; it arises, tendinous and fleshy, from the upper part of the os femoris, immediately below the trochanter major. Its origin commences in front, and passes obliquely around the bone to the linea aspera. It continues afterwards to arise from the whole length of the linea aspera, and from the upper half of the line running from it to the external condyle.

Its fibres pass inwards and downwards, and are inserted, by a flat tendon, into the external edge of the tendon of the rectus, and also into the external upper part of the patella. This muscle has a broad tendinous surface exteriorly and above; at its lower part it has a tendinous facing on the side next to the bone.

It also extends the leg.

The Vastus Internus

Covers the whole inside of the os femoris. It begins by a pointed fleshy origin, in front of the os femoris, just on a level with the trochanter minor; and then continues to arise tendinous and fleshy from the whole length of the internal edge of the linea aspera, and from the line leading from it to the internal condyle.

Its fibres descend obliquely, and are inserted, by a flat tendon, into

[1] Varieties. Sometimes a small fasciculus is detached from its inferior part; sometimes its fibres are interrupted by a middle tendon which adheres closely to the fascia femoris. Meckel reports it as deficient in one case that he met with. In the African I have occasionally seen it almost doubly broad.

the internal edge of the tendon of the rectus, and into the upper internal edge of the patella.

It also extends the leg.

The Cruræus

Is almost completely overlapped and concealed by the two vasti, and is immediately behind the rectus femoris. The edge of the vastus externus, above, is very distinguishable from it, as it overlaps it, and is rounded off, besides being somewhat separated by vessels. But the origin of the vastus internus is not so distinguishable, as the two muscles run into each other; it is, therefore, necessary, most frequently, to cut through some of their fibres on the internal face of the os femoris, on a level with the trochanter minor. The cruræus will be then seen to arise, fleshy, from all the fore part of the bone, and from all its outside as far as the linea aspera. Between the internal edge of this muscle and the linea aspera, the interior face of the os femoris is free or unoccupied, for the breadth of an inch along the whole shaft of the bone, which is very readily seen by turning off the vastus internus.

The cruræus is inserted into the posterior face of the tendon of the rectus below, and into the upper surface of the patella.

It also extends the leg.

A small fasciculus at the lower part of this muscle, which is inserted into the synovial membrane of the knee joint, is called the Sub-cruræus.[1]

The Ligamentum Patellæ is the common cord by which the action of the last four named muscles is communicated to the tibia. It is a flattened thick tendon, an inch and a half wide, arising from the inferior edge of the patella, and inserted into the tubercle of the tibia. Between its insertion and the head of the tibia, is a bursa. Besides this, a fascia or tendinous expansion (*involucrum*), an appurtenance of the fascia femoris, as mentioned before, comes from the inferior ends of these muscles, extends itself over the whole of the anterior and lateral parts of the knee joint, and is inserted into the head of the tibia and of the fibula. Through this it happens that, even when the patella or its tendon is ruptured, some motion or extension may be communicated to the leg from the thigh.

In consequence of the common insertion of these four muscles, some anatomists describe them as but one, under the name of Quadriceps Femoris.[2]

A bursa exists between the lower part of their tendon and the fascia femoris, higher up than the patella; occasionally, one is found still lower down, on the patella.[3]

The Gracilis

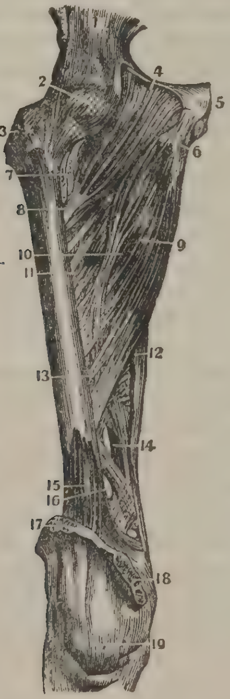
Is a beautiful muscle at the inner margin of the thigh, and lies immediately under the fascia; it extends from the pelvis to the leg.

1 Wilson's Anat, p. 229.
2 Sœmmering de Corp. Human. Fabr.
3 Some unimportant varieties have been observed in these extensor muscles.

It arises, by a broad thin tendon, from the front of the os pubis, just at the lower part of its symphysis, and from its descending ramus; the muscle tapers to a point below, and a little above the knee, terminates in a round tendon, which passes behind the internal condyle of the os femoris and the head of the tibia. It then makes a curve forwards and downwards at the internal side of the latter, and is inserted at the lateral and inferior part of its tubercle, just above the insertion of the semi-tendinosus.

The tendon at the knee is beneath the tendon of the sartorius. This muscle is a flexor of the leg.

Fig. 136.



A view of the Deep-seated Muscles on the Front of the Thigh.—1. Os ilium. 2. Capsular ligament of the hip-joint. 3. Trochanter major. 4. Origin of the pectineus muscle. 5. Symphysis Pubis. 6. Origin of the adductor longus. 7. Insertion of the iliacus internus and psoas magnus. 8. Insertion of the pectineus. 9. Middle of the adductor longus. 10. Tendinous insertion of the adductor longus. 11. Part of the adductor brevis seen between the pectineus and adductor longus. 12. Cut edge of the vastus internus. 13. Aperture for the passage of blood-vessels. 14. Opening for the femoral vessels 15. Portion of the cruræus. 16. A common defect in tendon of adductor magnus 17. Cut tendon of the quadriceps femoris. 18. Internal portion of the knee-joint. 19. Tendon of the patella.

The Pectinalis, or Pectineus,

Is a short, fleshy muscle, at the inner edge of the psoas magnus. It arises, fleshy, from the concavity on the upper face of the pubes, between the linea innominata, and the ridge above the obturator foramen, and is inserted, tendinous, into the linea aspera, immediately below the trochanter minor.

It draws the thigh inwards and forwards.[1]

The Adductors.

The *Triceps Adductor Femoris* is a large muscular mass, consisting in three distinct portions, placed at the inner side of the thigh, and contributing largely to fill the space between the thigh bones above. These portions are as follows:

1. *The Adductor Longus*, which comes, by a rounded short tendon, from the upper front part of the pubes near its symphysis; it forms a triangular belly, which increases in breadth in its descent, and is inserted into the middle third of the linea aspera at its inner edge.

As the subject lies on its back, this muscle is uppermost; its origin is between that of the pectinalis and of the gracilis; its upper edge is in contact with the lower edge of the pectinalis.[2]

2. *The Adductor Brevis* is the smallest of the three; it is situated beneath the adductor longus and pectinalis, and on the outside of the gracilis. It arises, by a rounded tendon, from the middle front part of the pubes, between its symphysis and the foramen thyroideum, just below the origin of the first adductor.

It is inserted into the upper third of the inner edge of the linea aspera, between the trochanter minor and the upper edge of the adductor longus, by a flat thin tendon.[3]

3. *The Adductor Magnus* is below the other two, and is by far the largest. It arises, fleshy, from the lower part of the body of the pubes and from its descending ramus; also from the ascending ramus of the ischium as far as its tuberosity, occupying the whole bony surface between the foramen thyroideum below, and the margin of the bone.

It is inserted, fleshy, into the whole length of the linea aspera, and on its internal margin a tendon is gradually generated, which passes downwards, to be inserted into the upper part of the internal condyle of the os femoris, and, by a thin edge or expansion more or less defective, into the line leading from the linea aspera to the internal condyle.

The adductor magnus separates the muscles on the anterior from such as are on the posterior part of the thigh; and its insertion is closely connected with the origin of the vastus internus, the two surfaces adhering by a short and compact cellular membrane.[4]

The three adductors contribute to the same end, that of drawing the thigh inwards. The pectineus muscle is also associated with them so

[1] Varieties. Sometimes this muscle is split into two by a fissure, in which case the lower portion is the smaller, and has its tendon below, connected or joined to the tendon of the other, and its other extremity attached to the upper internal margin of the thyroid foramen.

[2] Varieties. Occasionally this muscle is divided into two by a fissure, which is of various lengths. Sometimes it is continued much lower down by means of a small tendon united to that of the adductor magnus.

[3] Varieties. It is also occasionally split, more or less fully, into two muscles by a fissure which, according to Meckel, establishes a remarkable analogy with apes.

[4] Varieties. It also is occasionally divided into two portions, as in apes.

closely in its course and character, that, as Meckel has suggested, it ought to be considered as a fourth head to the triceps.

The Glutæus Magnus

Arises, fleshy, from the posterior third or fourth of the crista of the ilium, and the adjoining flat surface of the dorsum of the bone; from the side of the sacrum below it; from the side of the os coccygis, and from the posterior surface of the large sacro-sciatic ligament. The fibres of this muscle are collected into large fasciculi, with deep interstices between them; and the lower edge of it is folded over the posterior sacro-sciatic ligament.

Its fibres pass obliquely forwards and downwards, and terminate in a thick, broad tendon, the upper part of which goes on the outside of the trochanter major, and is very strongly inserted or blended into the fascia femoris; while the lower part is inserted into the upper third of the linea aspera, going down as far as the origin of the short head of the biceps flexor cruris.

This muscle is placed superficially, the fasciculi being separated to some depth by processes from the fascia femoris. It covers nearly all the other muscles on the back part of the pelvis, laps over its inferior margin laterally, and conceals the origins of the ham-string muscles.

There is a very large bursa placed between the tendon of this muscle and the external face of the trochanter major; another, of almost equal magnitude, between it, the superior extremity of the vastus externus, and the inferior end of the tensor fasciæ femoris; and there are two smaller ones between the same tendon and the os femoris, which are placed lower and more posteriorly.

The glutæus magnus draws the thigh backwards, and assists in keeping the trunk erect.

The Glutæus Medius

Arises from the whole length of the crista of the ilium, except its posterior third, or the part given to the origin of the magnus; from the part of the dorsum of the bone which is between its crista and the semicircular ridge, extending from the anterior superior spinous process to the sciatic notch; from the lunated edge of the os ilium, between the anterior superior and the anterior inferior spinous process; and largely from that part of the inner face of the fascia femoris which covers this muscle.

The anterior superior part of this muscle is not covered by the glutæus magnus, but lies before it. Its fibres converge, and are inserted by a broad thick tendon, into the upper surface of the trochanter major, and into the upper anterior part of the shaft of the bone just in front of this trochanter.

It draws the thigh backwards and outwards.

A bursa is interposed between the extremity of its tendon and the tendinous insertions of the small rotator muscles.

The Glutæus Minimus

Arises from that part of the dorsum of the ilium between the semicircular ridge just spoken of, and the margin of the capsular ligament of the hip joint. It is entirely concealed by the glutæus medius.

Its fibres converge and terminate in a round tendon, which is inserted into the anterior superior part of the trochanter major, just within the anterior insertion of the glutæus medius.

It abducts the thigh, and can also rotate the limb inwards.

A bursa of small size exists between its tendon and the trochanter major.

Fig. 137.

A view of the Deep-seated Muscles on the Posterior Part of the Hip Joint. 1. Fifth lumbar vertebra. 2. Ilio-lumbar ligament. 3. Crest of the ilium. 4. Anterior superior spinous process. 5. Origin of the fascia femoris. 6. Gluteus medius. 7. Its lower and anterior portion. 8. Pyriformis. 9. Gemini. 10. Trochanter major. 11. Ridge between trochanters. 12. Quadratus femoris. 13. Part of the adductor magnus. 14. Insertion of the gluteus magnus. 15. Vastus externus. 16. Long head of the biceps. 17. Semi-membranosus. 18. Semi-tendinosus. 19. Tuber ischii. 20. Obturator internus. 21. Point of the coccyx. 22. Posterior coccygeal ligament. 23, 24. Greater sacro-sciatic ligament. 25. Posterior superior spinous process of ilium. 26. Posterior sacro-iliac ligaments.

There are several small muscles about the hip joint, the most of which can be seen by the removal of the glutæus magnus.

The Pyriformis

Arises, fleshy and tendinous, within the pelvis, from the anterior face of the second, third, and fourth pieces of the sacrum. It forms a conical belly, which passes out of the pelvis at the upper part of the sacro-sciatic foramen, and receives a slip of fibres from the posterior inferior spinous process of the ilium.

It is inserted, by a round tendon, into the upper middle part of the trochanter major within the insertion of the glutæus medius.

It rotates the limb outwards. Between its tendon and the superior geminus a small bursa exists.[1]

The Gemini

Are two small muscles, closely connected with each other, which are situated lower down on the pelvis than the pyriformis. The upper one arises from the posterior part of the root of the spinous process of the ischium; the lower from the upper back part of the tuberosity of the ischium.

Being parallel to each other, and connected by their contiguous edges, they are inserted together into the fossa trochanterica upon the posterior part of the thigh bone at the root of the trochanter major.

They also rotate the limb outwards.[2]

The Obturator Internus

Is principally situated within the cavity of the pelvis. It arises, fleshy, from all the margin of the foramen thyroideum, except where the obturator vessels go out; from the posterior face of the ligamentous membrane stretched across it; also from the upper part of the plane of the ischium just below the linea innominata. Its fibres converge, and forming a tendon, pass out of the pelvis over the trochlea of the ischium, between the sacro-sciatic ligaments.

The tendon is placed between the gemini muscles, which form a sheath for it; and it is inserted into the pit (*fossa trochanterica*), on the back of the os femoris, at the root of the trochanter major.

Between the tendon of this muscle and the gemini is a long bursa; a second is found where the muscle plays over the ischium.

It rotates the limb outwards.

The Quadratus Femoris

Is lower down than the other muscles. It arises, tendinous and fleshy, on the outer side of the ischium, from the ridge which constitutes the exterior boundary of the tuberosity. Its fibres are transverse, and are inserted, fleshy, into the rough ridge of the os femoris, on its back part, which goes from one trochanter to the other.

[1] Varieties. It is sometimes split by the sciatic nerve, and when the latter divides very high up, by one of its portions only.

[2] Varieties. The upper one occasionally does not exist, whereby a striking resemblance with apes is established. Sometimes both are wanting.

It rotates the limb outwards. A bursa exists between it and the trochanter minor.[1]

The Obturator Externus

Is concealed, in front, by the pectineus and triceps adductor, and, behind, by the quadratus femoris: to get a satisfactory view of it, therefore, these muscles should be detached from the bone. It arises from the whole anterior circumference of the foramen thyroideum, excepting the place where the obturator vessels come out, and from the anterior face of the ligamentous membrane stretched across it.

The fibres of this muscle converge, pass beneath the capsular ligament of the hip joint, in adhering to it, and terminate successively in a round tendon, which is inserted into the inferior part of the cavity on the posterior surface of the os femoris, at the root of the trochanter major. The course of the tendon of this muscle is marked on the neck of the thigh bone by a superficial fossa.

It rotates the thigh outwards.

The Biceps Flexor Cruris

Constitutes the outer hamstring, and is situated on the posterior outer part of the thigh. It arises by two heads. The first, called the long head, has an origin, in common with the semi-tendinosus, from the upper back part of the tuberosity of the ischium, by a short tendon, which, in its descent, is changed into a thick fleshy belly. The other, called the short head, arises, by an acute fleshy beginning, from the linea aspera just below the insertion of the glutæus magnus, and this origin is continued along the lower part of the linea aspera and from the ridge leading to the external condyle.

A thick tendon is gradually formed on the outside of the muscle, which, descending along the external face of the external condyle, is inserted into the superior face of the head of the fibula at its point, or styloid process. A bursa is found between this tendon and the external lateral ligament of the knee.

This muscle flexes the leg on the thigh.[2]

The Semi-tendinosus

Is on the inside of the thigh, between the biceps and gracilis. It is superficial, being immediately under the fascia, and arises, in common with the biceps, from the back part of the tuberosity of the ischium; it also adheres, for three or four inches, to the inner edge of the tendon of this, the long head of the biceps.

[1] Varieties. Occasionally, this muscle is absent; more rarely it is divided into a great number of fasciculi, amounting in one instance to thirty.

[2] Varieties. Sometimes the short head does not exist, thereby affording an analogy with animals. Sometimes there is a third head, but more delicate, which comes either from the tuber of the ischium or from the long head, and descending along the back of the leg, runs into the tendo-Achillis, corresponding thereby with the arrangement of mammiferous animals.

About four inches above the knee it terminates in a long round tendon, which passes behind the internal condyle and the head of the tibia, and is reflected forwards to be inserted into the side of the tibia, just below its tubercle and very near it, being lower down than the insertion of the tendon of the gracilis. Its insertion is much connected with that of the gracilis, and is generally divided into two slips, one above the other.

Between its origin, that of the long head of the biceps, and the semi-membranosus, there is a bursa: one or more are likewise found between its tendon below, that of the sartorius, of the gracilis, and the internal lateral ligament of the knee.

It flexes the leg on the thigh.[1]

The Semi-membranosus

Is at the inner side of the thigh; its upper part is concealed by the semi-tendinosus and the origin of the long head of the biceps, and below it projects between these two muscles. It is in contact with the posterior surface of the adductor magnus.

It arises, by a thick round tendon, from the exterior upper part of the tuberosity of the ischium, which tendon soon becomes flattened, and sends off the muscular fibres obliquely from its exterior edge to a corresponding tendon below. The latter passes behind the internal condyle and the head of the tibia, and despatches a thin aponeurotic membrane under the inner head of the gastrocnemius, to cover the posterior part of the capsule of the knee joint, and to be fastened to the external condyle.

It is inserted, by a round tendon, into the inner and back part of the head of the tibia, just below the joint. The unfavorable insertion of this muscle is compensated for, by the multitude of its fibres, which gives it a great increase of strength.

A bursa exists between its tendon above and the quadratus; another exists between its tendinous termination, the internal head of the gastrocnemius, and the capsule of the knee.

It flexes the leg on the thigh.

SECT. III.—MUSCLES OF THE LEG.

These muscles are situated anteriorly, posteriorly, and externally.

The Tibialis Anticus

Is situated superficially under the fascia of the leg, at the outside of the spine of the tibia, and in front of the interosseous ligament. It arises, fleshy, from the head of the tibia, from its outer surface, spine, and from the interosseous ligament to within three or four inches of the ankle. It also arises, by its front surface, from the interior face of the fascia of the leg.

[1] Varieties. Sometimes it is divided into three sections by two transverse tendinous lines.

A rounded long tendon is formed in front below, into which the fleshy fibres run obliquely, and which, passing through a distinct noose of the annular ligament in front of the malleolus internus, crosses the astragalus and os naviculare, and is inserted on the inner side of the sole of the foot into the anterior part of the base of the cuneiforme internum, and into the adjacent part of the metatarsal bone of the great toe.

A bursa surrounds the tendon where it passes beneath the annular ligament; another also exists at its lower part.

This muscle corresponds with the radial extensors of the arm.

It bends the foot, and presents the sole obliquely inwards.

The Extensor Longus Digitorum Pedis

Is also superficially placed just under the fascia of the leg and in front of the fibula, being in contact above with the tibialis anticus, and below with the extensor proprius pollicis. It arises, tendinous and fleshy, from the outer part of the head of the tibia; from the head of the fibula, and almost the whole length of its anterior angle; also from the upper part of the interosseous ligament and the internal face of the fascia of the leg.

Its fibres go obliquely downwards and forwards to the tendon which begins not far from its upper end, and descends along its anterior margin. About the middle of the leg the tendon splits into four, which are confined by the annular ligament of the ankle, and then diverging, each is inserted into the base of its respective toe, the big one excepted, and expanded over its back part as far as the last phalanx.

When these four tendons first reach the roots of the toes, they expand over the back of the articulation there, and send downwards triangular processes which are attached to the base of the first phalanx, and to the tendinous terminations of the interosseous muscles. On the back of the first joint the tendon adheres closely to its synovial membrane, and is somewhat cartilaginous. At the second joint the tendon is inserted into the second phalanx, and splits partially into two, which pass somewhat laterally, and then reunite. The tendon then adheres again closely to the synovial membrane of the third articulation, and finally terminates in the base of the third phalanx.

A long bursa is found enveloping the tendons, where they pass beneath the annular ligament of the ankle.

It extends all the joints of the small toes, and flexes the foot.

The Peroneus Tertius

Is rather a portion of the extensor longus digitorum pedis; is found at its lower outer part, and cannot be naturally separated from it. It arises from the anterior angle of the fibula, between its middle and lower end.

It is inserted, by a flattened tendon, into the base of the metatarsal bone of the little toe, and assists in bending the foot.

The Extensor Proprius Pollicis Pedis

Is between the lower part of the tibialis anticus, and of the extensor longus. It arises from the fibula between its anterior and internal angles, by a tendinous and fleshy origin, which commences about four inches below the head of the fibula, and continues almost to its inferior extremity. A few fibres also come from the interosseous ligament, and from the lower part of the tibia.

The muscle being half penniform, the fibres run obliquely to a tendon at its fore part, which passes through a particular gutter of the annular ligament, and over the astragalus and scaphoides and upper internal parts of the foot, to be inserted into the base of the first and second phalanx of the great toe. A bursa invests this tendon where it passes beneath the annular ligament.

It extends, as its name implies, the great toe.[1]

On the outside of the leg, between the fibula and fascia, are the two Peronei muscles.

The Peroneus Longus, seu Primus,

Arises, tendinous and fleshy, from the fore and outside of the head of the fibula, from the space on its outer side above, between the external and anterior angles; also, from its external angle to within a short distance of the ankle.

A flattened thick tendon, to which the fibres pass obliquely, constitutes the outer face of the muscle. This tendon is lodged in the groove at the posterior part of the malleolus externus, being confined to it by a thick ligamentous noose, and furnished there with a bursa; it then traverses the outer side of the os calcis, where its passage is marked by a superficial sulcus; from that it runs upon the groove of the os cuboides, where there is another bursa. It lies deep in the sole of the foot, covered by the calcaneo-cuboid ligament, and next to the tarsal bones, and is inserted into the base of the internal cuneiform bone, and into the adjacent part of the metatarsal bone of the great toe.

It extends the foot and inclines the sole obliquely outwards. It corresponds with the flexor carpi ulnaris of the fore arm.

As the tendon experiences much friction at the ankle, on the os calcis, and where it winds around the os cuboides, it is not unusual to find in it there small sesamoid bones, especially at the latter place.

The Peroneus Brevis, seu Secundus,

Is concealed in a great degree by the peroneus longus, being situated between the latter and the extensor longus digitorum pedis. It arises, tendinous and fleshy, from the outer surface of the fibula, commencing about one-third of the length of the bone from its head, and continuing almost to the ankle.

A tendinous facing exists externally also in this muscle, to which its fibres proceed obliquely. This tendon is continued through the fossa

[1] Varieties. A partial effort is sometimes manifested to divide it into two muscles.

at the back part of the malleolus externus, being covered by the tendon of the peroneus longus, and confined by the same ligamentous noose; passing through the superficial fossa at the outer side of the os calcis, it is inserted into the external part of the base of the metatarsal bone of the little toe.

It extends the foot, and presents the sole obliquely downwards. It also corresponds with the flexor carpi ulnaris.[1]

Triceps Suræ.

The muscular mass on the back of the leg, constituting its calf, is formed by the two following muscles, which, with much reason, may be considered as composing only one. Anatomists, who view them in this latter light, describe them under the name of Triceps Suræ, of which the Gastrocnemius portion has two heads, and the Soleus, or Gastrocnemius internus, but one.

1. The *Gastrocnemius* is the most superficial muscle on the back of the leg, and conceals the other, in consequence of its breadth. It comes from the condyles of the os femoris by two heads. One head arises, tendinous, from the upper back part of the internal condyle, and fleshy from the adjacent part of the ridge leading to the linea aspera: the other head arises, by a broad tendon in the same way, from the external condyle and the ridge above it. A triangular vacancy is left between the heads of the muscle for the passage of the popliteal vessels; the heads then join together, but in such a way that the appearance of two bellies is distinctly preserved, of which the internal is the larger. The muscular fibres pass from a broad tendinous facing on the back to a corresponding one on the front surface of the muscle, from the latter of which comes the Tendo-Achillis.

2. The *Soleus* is beneath the Gastrocnemius, and arises, fleshy, from the posterior part of the head of the fibula, and from the external angle of that bone, for two-thirds of its length down, behind the peroneus longus. It also arises, fleshy, from the oblique ridge on the posterior surface of the tibia, just at the lower edge of the popliteus muscle, and from the internal angle of the tibia for four or five inches. The two origins are separated for the passage of the posterior tibial vessels.

The body of this muscle has a great intermixture of tendinous matter with it, and from its lower extremity proceeds another origin of the tendo-Achillis. About three or four inches above the heel, this tendon joins the anterior face of the tendon of the gastrocnemius, and by the union of the two the tendo-Achillis is completed, and then inserted into the posterior surface of the os calcis near its tuberosities. The tendon becomes more round as it descends.

These muscles extend the foot, and are all important in walking. A bursa is between their tendon and the os calcis.

[1] Varieties. Sometimes it is double.

The Plantaris

Is a singular little muscle, concealed by the gastrocnemius, and has a short fleshy belly and a long tendon. It arises, fleshy, from the ridge of the os femoris, just above the external condyle, passes across the capsular ligament of the joint, and adheres to it in its course; the belly terminates somewhat below the head of the tibia, in a long, delicate tendon, which descends between the inner part of the soleus and the gastrocnemius.

At the place where the tendons of these unite, the tendon of the plantaris emerges from between them, and, running at the inner edge of the tendo-Achillis, is inserted into the inside of the os calcis, just before the insertion of the latter.

It extends the foot. This muscle is sometimes wanting. It contributes so little to the motions of the foot, and, in other respects, is of such doubtful use, that its proper destination is uncertain, or at any rate may be limited to the drawing of the capsular ligament out of the way in the flexions of the leg. In some mammiferous animals it is large and important. In the human subject it is one of the links connecting us with animals, of which there are so many evidences in the muscular system.

The Popliteus

Is a triangular muscle on the back of the knee joint. It arises from a deep depression on the exterior face of the external condyle, by a thick round tendon, which passes through the capsular ligament, and is connected with the external semilunar cartilage. It then forms a fleshy belly which proceeds obliquely inwards and downwards.

It is inserted fleshy into the oblique ridge on the back of the tibia, just below its head, and into the triangular depression above it. A bursa exists between its origin and the capsular ligament; its tendon is in contact with the synovial membrane of the joint.

It bends the leg, and rotates it inwards, when bent.

The Flexor Longus Digitorum Pedis Perforans

Is behind the tibia, and at the inner edge of the tibialis posticus. It commences, by an acute, tendinous and fleshy beginning, from the back of the tibia, a little below the popliteus muscle; its origin is continued along the posterior surface of the tibia almost to the ankle joint. It arises, also, by tendinous and fleshy fibres, from the outer edge of the tibia, just above its connection with the fibula at the ankle: the latter origin is frequently deficient, and between this double order of fibres the tibialis posticus passes.

The fibres go obliquely at the posterior edge of the muscle, into a tendon, which runs in the groove behind the internal malleolus, and is confined there by a strong ligamentous sheath. The tendon is placed behind, and within the tendon of the tibialis posticus. The tendon then gets to the sole of the foot along the sinuosity of the os calcis, and being joined by a considerable tendon, detached from the flexor longus

pollicis, it divides into four branches which are appropriated to the four smaller toes.

These tendons are inserted into the base of the third phalanges of the lesser toes, are very near the tarsal bones, and, from perforating the tendons of the flexor brevis, correspond with the flexor perforans of the hand. A bursa exists where the tendon passes along the tibia and the os calcis; and another is found in the sole of the foot, enveloping this tendon and that of the flexor longus pollicis.

A fifth tendon is sometimes observed, which splits and goes to the second phalanx of the small toe: this occurs when the latter is not supplied from the flexor brevis.

This muscle flexes the small toes, and extends the foot.

The Flexor Longus Pollicis Pedis

Is a stout muscle formed of oblique fibres, and situated on the back part of the fibula, at the outer side of the tibialis posticus. It arises by an acute, tendinous and fleshy beginning, from the posterior flat surface of the fibula, commencing about three inches from its head, and continues almost to the ankle.

The tendon of this muscle is large and round; it forms gradually, and constitutes a facing to the posterior edge of the muscle. It passes through a superficial fossa of the tibia, at the back of the angle near its middle, and from thence through a notch in the back edge of the astragalus to the sole of the foot; at the latter place it crosses the tendon of the flexor longus digitorum, and gives off to it the branch just mentioned, which goes, principally, to the second toe. This tendon is deeper seated in the foot than the other.

The tendon of the flexor longus pollicis is inserted into the second phalanx of the great toe.

It bends the great toe, and from its connection with the others will bend them also. A bursa invests its tendon in the canal of the astragalus, and along the os calcis; another, as stated, is common to it and the flexor perforans muscle; and a third invests the tendon along the metatarsal bone, and the first phalanx of the great toe.[1]

The Tibialis Posticus

Is placed between, and concealed by the last two muscles. It arises by a narrow fleshy beginning, from the front of the tibia, at the under surface of the process which joins it to the fibula, and then gets to the back of the leg through the hole in the upper part of the interosseous ligament. It continues its origin from the whole of the interosseous ligament, and from the surfaces of the tibia and fibula bordering on this ligament, excepting one-third of the lower part of the fibula, and rather more of the lower part of the tibia.

The fleshy fibres run obliquely to a middle tendon which passes in the groove at the back of the malleolus internus, and is confined there

[1] The variations in this muscle consist, principally, in the manner of distributing its tendon to that of the small toes, and frequently this connection is deficient.

by a fibro-cartilaginous noose, and invested by a bursa. It is inserted into the posterior intèrnal part of the os naviculare or scaphoides, at its tuberosity; and also divides in such a way as to be inserted into the internal and external cuneiform bones, into the os cuboides, and os calcis.

It extends the foot, and presents the sole obliquely inwards. It corresponds with the flexor radialis of the hand.

SECT. IV.—OF THE MUSCLES OF THE FOOT.

The Extensor Brevis Digitorum Pedis

Is a muscle situated on the superior surface of the foot. It is placed beneath the tendons of the extensor longus, and arises, tendinous and fleshy, from the fore upper part of the greater apophysis of the os calcis, being intermixed with the origin of the annular ligament of the ankle. It forms a short, fleshy belly, which is partially divided into four parts; from these parts proceed as many tendons, which, crossing very obliquely the tendons of the extensor longus, are inserted into the great toe, and the three next toes, by joining with the tendons of the extensor longus, which are spread over their backs. The tendon going to the great toe has its principal insertion into the first phalanx.

It extends the toes.[1]

When the Aponeurosis Plantaris is removed from the sole of the foot, we see three muscles; the middle one having been covered by the large central portion of the Aponeurosis, is the Flexor Brevis Digitorum Pedis; the outer is the Abductor Minimi Digiti Pedis; and the inner, the Abductor Pollicis Pedis.

The Flexor Brevis Digitorum Pedis

Arises, fleshy, from the larger tuberosity of the os calcis, by a narrow beginning; also from the upper surface of the aponeurosis plantaris, and the aponeurotic septa between itself and the contiguous muscles.

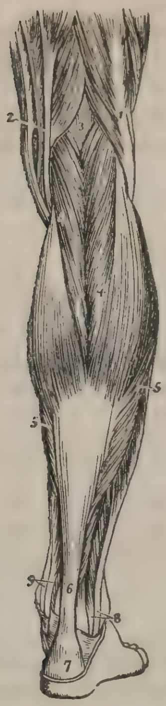
It forms a fleshy belly, going nearly as far forwards as the middle of the metatarsal bones; there it divides into four tendons, which go to the four smaller toes. These are perforated by the tendons of the flexor longus, and are inserted into the sides of the second phalanges. The tendon for the little toe is often deficient.

It bends the second joint of the toes.

By detaching this muscle from its origin, and turning it down, we bring into view the tendon of the Flexor Longus Digitorum Pedis; and the attachment of the latter to the tendinous slip from the Flexor Longus Pollicis,—to the Flexor Accessorius, or Massa carnea Jacobi Sylvii,—and to the Lumbricales Muscles.

[1] Varieties. The internal part, or belly, is sometimes distinct from the adjoining. In some very rare cases all the bellies are insulated, as in birds. Sometimes it sends a tendon to the little toe.

Fig. 138.



A view of the Muscles on the back of the leg. 1. Tendon of the biceps. 2. Inner hamstring tendons. 3. Popliteal space. 4. Gastrocnemius. 5. Soleus. 6. Tendo-Achillis. 7. Its insertion on the os calcis. 8. Tendons of the peroneus longus and brevis. 9. Tendons of the tibialis posticus and flexor longus digitorum behind the internal malleolus.

The Flexor Accessorius

Is at the outside of the tendon of the flexor longus digitorum pedis. It arises, fleshy, from the inside of the sinuosity of the os calcis, and, by a thin tendon, from the outside of the same bone before its posterior tuberosities.

It is inserted, fleshy, into the outside of the tendon of the flexor longus just at its division into four tendons. Like a second hand to a rope, it assists in flexing the toes.

The Lumbricales Pedis

Are four small tapering muscles, which arise from the tendon of the flexor longus digitorum pedis, just after its division, or while it is in the act of dividing. One of them is appropriated to each lesser toe, and is inserted into the inside of its first phalanx, and into the tendinous expansion that is sent off from the extensor muscles to cover its dorsum.

They increase the flexion of the toes, and draw them inwards.

The Abductor Pollicis Pedis

Arises, tendinous and fleshy, from the internal anterior part of the large tuberosity of the os calcis; from a ligament being a part of the aponeurosis of the sole of the foot extended from this tuberosity to the sheath of the tendon of the tibialis posticus; from the internal side of the naviculare, and from the cuneiforme internum.

It forms the internal margin of the sole of the foot, and is inserted, tendinous, into the internal sesamoid bone, and into the base of the first phalanx of the great toe.

It draws the great toe from the rest.

From the inner division of the Aponeurosis plantaris, a muscle sometimes is found to arise in the hollow of the foot, and to cross the latter in an outward direction, to be inserted into the skin of the foot tendinously; it is an inch long, and about three lines wide.[1]

The Flexor Brevis Pollicis Pedis

Is situated immediately at the exterior edge of the abductor pollicis. It consists of two bellies, which are parallel with each other, and separated by the tendon of the flexor longus pollicis; one is inseparably connected with the tendon of the abductor pollicis, and the other with the adductor pollicis pedis.

It arises, in common with the calcaneo-cuboid ligament, tendinous, from the under part of the os calcis, just behind its connection with the os cuboides, and from the under part of the external cuneiform bone.

The internal belly is inserted, tendinous, into the internal sesamoid bone, along with the tendon of the abductor pollicis, and the external belly is inserted, tendinous, into the external sesamoid bone, along with the tendon of the adductor pollicis. Each insertion is continued to the base of the first phalanx of the great toe.

It flexes the great toe.

The Adductor Pollicis Pedis

Is situated at the outside of the flexor brevis pollicis, and is extended obliquely across the metatarsal bones. It arises, tendinous, at the external part of the foot, from the calcaneo-cuboid ligament, and from the bases of the three outer metatarsal bones.

It is inserted, tendinous, into the external sesamoid bone, which insertion is continued to the first phalanx of the great toe. It is closely united to the tendon of the external head of the flexor brevis pollicis.

It draws the great toe towards the others.

[1] An example occurred to me in a black female, January 15th, 1845.

The Abductor Minimi Digiti Pedis

Forms the external margin of the sole of the foot, and is immediately beneath the aponeurosis plantaris. It arises, tendinous and fleshy, from the outer tuberosity of the os calcis, and also from the exterior part of the base of the metatarsal bone of the little toe.

It is inserted by a rounded tendon into the exterior part of the base of the first phalanx of the little toe.

It draws the little toe from the other toes.

The Flexor Brevis Minimi Digiti Pedis

Is just within the tendon of the abductor minimi digiti. It arises from the calcaneo-cuboid ligament as extended from the tuberosity of the cuboid bone to the bases of the two outer metatarsal bones; also from the base of the outer or fifth metatarsal bone.

It is inserted, by a tendon, into the lower part of the first phalanx of the little toe, at its base, and into the head of the metatarsal bone of the same toe.

It bends the little toe.

The Transversalis Pedis

Is placed beneath the tendons of the flexor muscles.[1] It is small, and lies across the anterior extremities of the metatarsal bones. It arises, tendinous, from the capsular ligament of the first joint of the little toe; it also arises from the capsular ligament of the first joint of the next toe.

It is inserted into the exterior face of the common tendon of the adductor and the flexor brevis pollicis, at the external sesamoid bone.

It approximates the heads of the metatarsal bones.

The Interosseous Muscles are seven in number, four of which may be seen on the upper surface of the foot. There are two to the first smaller toe, two to the second, two to the third, and one to the fourth, or little toe. The muscles seen on the upper side of the foot are double-headed, that is, they arise from the contiguous surfaces of the metatarsal bones.

The Interosseus Primus, Digiti Primi, or the Abductor Indicis Pedis,

Is seen superiorly. It is placed between the metatarsal bone of the great toe, and the first small toe, and arises, fleshy, by a double head, from the opposed surfaces of their roots and bodies.

It is inserted, tendinous, into the inside of the root of the first joint or phalanx of the first small toe, and pulls it inwards.

[1] The sole is presumed to be upwards.

The Interosseus Secundus, Digiti Primi, or the Adductor Indicis Pedis,

Is also superficial or above. It is situated between the metatarsal bones of the first and second small toes, arising from the opposed surfaces of their roots and bodies by a double, fleshy, and tendinous head.

It is inserted into the outside of the first phalanx of the same toe, by a tendon.

It draws this toe outwards.

The Interosseus Secundus, Digiti Secundi, or the Adductor Medii Digiti Pedis,

Is seen at the upper part of the foot between the second and third metatarsal bones of the lesser toes, arising from the opposite surfaces of their roots and bodies.

It is inserted, tendinous, into the outside of the base of the first phalanx of the second small toe.

It draws this toe outwards.

The Interosseus Secundus, or the Adductor Digiti Tertii Pedis,

Is seen on the upper surface of the foot, occupying the interval of the metatarsal bones of the third and fourth small toes, and arises, by a double head, from the opposite surfaces of their roots and bodies.

It is inserted, tendinous, into the outside of the root of the first phalanx of the third small toe.

It draws this toe outwards.

The Interosseus Primus, Digiti Secundi, or the Abductor Medii Digiti Pedis,

Is at the bottom of the foot, and arises from the inside of the metatarsal bone of the second smaller toe.

It is inserted into the inside of the first phalanx of the second toe.

It draws this toe inwards.

The Interosseus Primus, or the Abductor Digiti Tertii Pedis,

Is in the sole of the foot. It arises from the inside of the metatarsal bone of the third smaller toe, beginning near its root, and is inserted, tendinous, into the inside of the base of the first phalanx of the same toe.

It draws this toe inwards.

The Interosseus, or the Adductor Digiti Minimi Pedis,

Is on the under surface of the foot. It arises from the inside of the base and body of the metatarsal bone of the fourth smaller, or the little toe, and is inserted, tendinous, into the inside of the first phalanx of the little toe.

It draws this toe inwards.

BOOK IV.

OF THE ORGANS OF DIGESTION.

The Organs of Digestion consist in an uninterrupted canal extending from the lips to the anus, and of numerous glandular organs placed all along its track, for pouring their secretions into it.

This canal, called Alimentary (*ductus cibarius*), is in three principal portions: the superior; the middle; and the inferior or terminating. The superior portion is composed of the mouth, the pharynx, and the œsophagus:—the middle of the stomach and small intestines: and the inferior, of the large intestines.

The Glandular organs are the salivary glands, the pancreas, the liver, the spleen, and an extremely numerous set of muciparous glands, extending from one end to the other of the canal.

The organs of digestion may be divided, according to their physiological functions, into those of mastication and deglutition; and into those of assimilation.

BOOK IV.

PART I.

ORGANS OF MASTICATION AND DEGLUTITION.

CHAPTER I.

OF THE MOUTH.

The Mouth (*cavum oris*) occupies the space in the inferior part of the face, between the upper and the lower jaw. It is separated from the nose by the palatine processes of the superior maxillary and palate bones, and by the soft palate, which is continued backwards from them. It extends from the lips, in front, to the soft palate and pharynx behind, and its floor is formed by the mylo-hyoid muscles.

Fig. 139.

A view of the cavity of the Mouth, as shown by dividing the Angles of the Mouth and turning off the Lips.—1. The upper lip turned up. 2. Its frænum. 3. The lower lip turned down. 4. Its frænum 5. Internal surface of the cheeks. 6. Opening of duct of Steno. 7. Roof of the mouth. 8. The anterior portion of the lateral half arches. 9. The posterior portion of the lateral half arches. 10. The velum pendulum palati. 11. The tonsils. 12. The tongue.

The anterior and lateral periphery of the mouth is constituted by the muscles of the lips and cheeks, covered externally by common integu-

ments, and internally by the lining membrane of the mouth. The cavity of the latter is divided into two portions by the projection of the teeth and of the alveolar processes of the upper and of the under jaw; these two portions, when the teeth are complete, are separated from each other while the mouth is closed. The anterior portion, which is sometimes called the vestibule of the mouth (*vestibulum oris*), varies its size very considerably in mastication, and has its parietes extremely movable. The capaciousness of the posterior admits also of much change, by the motions of the tongue and by the depression of the lower jaw.

The whole cavity of the mouth is lined by a membrane (*membrana oris*), continued over the lips from the skin, and, in many respects, strongly resembling the texture of the latter, inclusive of the papillæ tactus; it is, however, much finer; is furnished everywhere with an epidermis; is very vascular, and has beneath it a great number of small glands. Its texture undergoes some changes, according to its position, upon the lips and cheeks, upon the gums and palate, and upon the tongue; all of which will be explained in due season.

This lining membrane of the mouth, for the most part thin and very flexible, forms, at several points, folds or duplicatures. Four of them are situated on the middle line of the mouth, and are called frenula; one goes from the posterior face of the upper lip to the middle palate suture in front of the central alveolar processes of the upper jaw; a second goes from the posterior face of the lower lip to the front of the symphysis of the lower jaw; a third goes from the under part of the tongue to the posterior face of the symphysis of the lower jaw (*frænulum linguæ*); and the fourth goes from the front of the epiglottis cartilage to the middle of the root of the tongue. Besides these, there are some other duplications, which will be mentioned in their proper order.

Fig. 140.

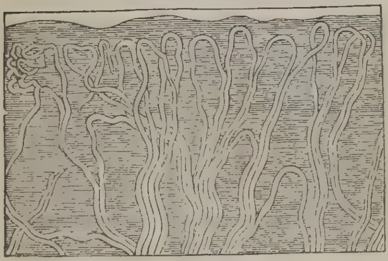


Fig. 141.

Fig. 140. Distribution of the nerves of touch upon the surface of the lip, as exhibited under the microscope by a thin perpendicular section of the skin.
Fig. 141. Capillary net-work upon the margin of the lips; highly magnified.

The lips (*labia*) are always somewhat thicker at their loose margins than elsewhere; the skin which covers them there, is remarkable for its vascularity, and changes its texture insensibly, as it is continued from the face to the lining membrane of the mouth.

The upper lip is longer and thicker than the lower, is somewhat pointed in the centre, and has on its front surface a vertical depression (*philtrum*), beginning at the septum of the nose and going downwards

to the centre of the lip. This depression is the remains of a fissure which always exists between the two halves of the lip in the early fœtal or forming stage. The junction of the extremities of the lips constitutes the corners of the mouth (*anguli oris*).

The lips are composed of muscular fibres, much blended with adipose matter. The muscles which concur to form them are the orbicularis oris and the buccinators; besides which, the upper lip is furnished on each side with the two levatores, with the depressor and the zygomatici; while the lower lip has its two depressors and a levator. (See Muscles of the Face.)

CHAPTER II.

OF THE TEETH.

The Teeth (*dentes*) are by far the hardest portions of the human fabric; and though they bear in their composition and appearance a strong analogy with bone, yet they differ from it in their more limited duration, in their mode of development, their partial nudity, their mode of nutrition, and in the manner by which they are united to the body.

SECTION I.

The whole number of teeth in the adult is thirty-two, sixteen in each jaw, and, when healthy, they are all fixed with so much firmness by the gomphosis articulation, that the very slight degree of motion which, by force, they may be caused to execute, is scarcely perceptible.

The greater part of the length of each tooth is implanted into the alveolar process of the jaw, and the part so fixed is technically called the root; immediately beyond this a small portion of the tooth is embraced by the gum, this is the neck; and the free, or projecting part of the tooth, covered with a shining porcelain-like layer called the enamel, is its body. The body is hollow, and has a conical extension along each root to the point of the latter, where it terminates in an orifice, the size of a small bristle.

The differences existing in their shape have caused anatomists to classify them accordingly; on each side of the middle line of each jaw there are two Incisors, one Cuspated, two Bicuspated, and three Molar teeth. There are also some peculiarities, as they belong to the upper or to the lower jaw; but they correspond exactly with their fellows on the opposite side of the same jaw.

The Incisors (*dentes incisivi*) are next to the middle line, and are named from their being brought to a straight cutting edge, like a chisel, they being bevelled from behind. They are somewhat convex on their anterior face, but behind they are very concave. Owing to their thin-

ness for some distance from the cutting edge, they are apt to be broken. In early life, their cutting edge is slightly serrated. They have each but one root, which is conoidal, terminates by a small point, and is not unfrequently impressed longitudinally on each side by a superficial furrow.

The central incisors of the upper jaw are broader and longer than the outer ones; the anterior face of the latter is more convex, and their cutting edge more rounded. The incisors of the lower jaw are much narrower than those of the upper, and have their roots flattened on the sides. They do not differ remarkably among themselves, except that the external ones are somewhat wider than the internal.

The enamel of the incisors is continued farther down, and is thicker on their anterior and posterior faces than laterally; it is also thicker on the front than on the back part.[1]

The Cuspated Teeth (*dentes cuspidata*, *canini*) are next to the incisors, one on each side. Their body is conoidal, and is brought to a sharp point at its summit; the principal obliquity in effecting the latter, being on the side of the interior of the mouth. They are more convex externally than the incisors, but not so concave internally; they are also thicker and more cylindroid. They have each but one root, which is conoidal, and which, as also the body, is longer than the corresponding portion of any of the other teeth. They stand nearly perpendicularly, and are more covered on their sides with enamel than the incisors.

The cuspated teeth of the upper jaw have longer roots than those of the lower, and are called, in common language, eye-teeth: those of the lower jaw are called stomach teeth.

The Bicuspated Teeth (*dentes bicuspidati*), two in number on each side, are situated behind the cuspate; they are also called small molar. They are almost precisely alike, with the exception that the first is smaller than the other, and resembles rather more the type of the cuspidatus than the second does. Their body is very nearly cylindrical, being flattened, however, on the faces next to the adjoining teeth. The masticating surface of the body is formed into two points, whence the name; one external, and the other internal: the former is the longer and thicker, and consequently, the most conspicuous. The enamel forms an almost circular crown, covering the bodies of these teeth. The root of each one is single, but has a deep and well marked fossa on each side running its whole length, and presenting the semblance of an effort at duplicity; it is also conoidal, and sometimes in the upper jaw bifurcated at its end.

The bicuspate teeth of the upper and of the lower jaw resemble each other so strongly that the difference between them is not striking; it is, however, determined by those of the upper jaw being rather more voluminous and ovoidal in their bodies, and having rather longer and larger roots.

[1] Natural History of the Human Teeth, by J. Hunter, London, 1778.

The Molar Teeth (*dentes molares*), three in number, on each side, succeed the bicuspated. They are well characterized by their greater size. Their bodies are almost cuboidal, with rounded angles, and are protected with a circular crown of enamel; their grinding surface has five points, three externally, and two internally: the rule, however, is not uniform, as they frequently have only four, and sometimes in the upper jaw only three points.

The first molar is the largest of any, and very generally has five points; in the upper jaw it has three roots, two of which are outward, and the other inward; but in the lower jaw it has only two roots, one before the other.

The second molar of each jaw, with the exception of its being smaller than the first, presents no essential difference from it, either in regard to its body or roots. The fifth point is sometimes not so well developed.

The third molar resembles the other two in its body, but is smaller than either of them. Most frequently its roots, instead of diverging from each other and standing out distinctly, are imperfectly developed, and stick together. Some slight separation at their extremities, and the longitudinal depressions on their sides, mark the effort to form three roots for the tooth of the upper jaw, and two for the lower, according to the general rule. Owing to this tooth growing at the posterior extremity of the alveolar processes, in a place where, from the preceding development of the other teeth, it is much cramped for room, it is not only imperfectly evolved in most cases, but it often takes a very irregular direction; its grinding surface sometimes looking forwards and sometimes backwards.

The Alveolar Processes in each jaw form a semi-elliptical row of sockets, for the insertion of the roots of the teeth into them. These processes and the teeth, as Mr. Hunter has very properly explained, have such a mutual dependence upon each other, that the destruction of the one is inevitably followed by that of the other: "If we had no teeth, it is likely we should not only have no sockets, but not even those processes in which the sockets are formed."[1] The semi-elliptical arrangement observed by the teeth is such, that when the mouth is closed, the exterior circumference of the row above projects beyond that below; this is more obviously the case in front; but it also prevails at the sides, and depends primarily upon the greater breadth of the incisors of the upper jaw. The grinding surface of the under row, as a plate, is slightly concave from before backwards, while the opposed surface of the upper row has a corresponding convexity. Each row, viewed collectively, forms a single edge, in front; but after having passed the cuspidati, it becomes thicker, forms a double edge, and is continued backwards in that state.

A question of some interest has recently arisen in regard to the precise apparatus of attachment of the fangs of both sets of teeth to their alveolar cavities. The principal cause of attachment is attributed to a distinct ligament or fasciculus for each tooth, having for

[1] Loc. cit. p. 7.

its position the side of the tooth the most distant from the front line of the symphysis of the jaw. The ligament thus situated is said to arise from the edge of the alveolus between the teeth, and proceeding forwards in the case of the molars, and inwards in the case of the incisors, to be inserted into the neck of the tooth not quite the sixteenth part of an inch from the enamel. The ligamentous character is considered as very distinct, the fibres being white and shining like tendon. The exclusive cutting of it is also said to facilitate very much the extraction of a tooth.[1]

My own observations, made upon the parts softened in muriatic acid, and in the recent state, have not led me to see the ligamentum dentis in so distinct a light, or to witness the extreme facility of extraction after it alone is cut. It is, however, probable that the insinuation of an instrument between the tooth and alveolus will generally, to the extent of the incision, diminish the force of resistance in pulling the tooth out. The actual adhesion of the tooth to the alveolus appears to me to arise from the original capsules of the tooth being converted into a single layer of periosteum, the peri-odontal membrane (*peri-odonteum*), one surface of which adheres to the alveolus, and the other to the fang of the tooth. The adhesion I have found particularly strong at the margin of the alveolus, and converging circularly from it to the neck of the tooth, somewhat in the manner of a coronary ligament. Another subject of remark is, that the filaments of periosteum are not laid down laterally to the teeth, but one end of the filament adheres to the alveolus, and the other to the tooth, like the filaments of the interosseous ligament at the lower junction of the tibia and fibula. In this way a cap of such fibres is found over the whole fang of the tooth: one of the best means of demonstrating it is to chip off the alveolus in front of a cuspate tooth of the lower jaw, then seize the body of the tooth with a pair of strong pliers, and make it rotate on its axis; the fibres will thus be seen to start up and to show the attachment of their two ends, one to the alveolus, and the other to the tooth. The jaw of a strong muscular subject is especially recommended. This arrangement of the course of the fibres is very well exhibited in the cow and horse.

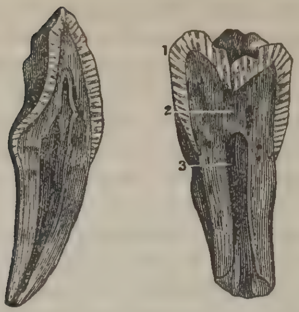
SECT. II.—OF THE TEXTURE AND ORGANIZATION OF THE TEETH.

The teeth consist in three kinds of substance, one of which is Enamel, another Ivory or Dentine, and the third Cortical or Bony, also called Cement.

The Enamel forms the periphery of the body of a tooth, and is distinguished by its whiteness, its brittleness, its semi-transparency, and a hardness so considerable that it soon takes down the edge of the best tempered saw or file, so that it is very difficult to penetrate it. It forms a crust upon the body scarcely half a line in thickness, is more abundant upon the grinding surface, and is reduced to a thin edge where it

[1] See Description of the Ligamentum Dentis, by Paul B. Goddard, M. D., in Am. Journ. of Med. Sciences, vol. xxiii. Phil. 1839.—Also a work of much value, the Anat. Physiol. and Pathol. of the Teeth, parag. 144, by Paul B. Goddard, M. D., &c., and Joseph E. Parker, Phil. 1844.

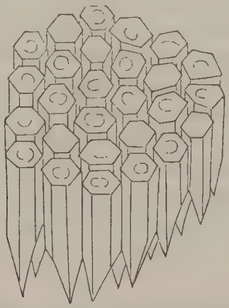
Fig. 142.



A view of an Incisor and of a Molar Tooth, in longitudinal section. 1. The enamel. 2. The dentine. 3. The pulp-cavity.

terminates at the neck. When broken, it is seen to be composed of minute hexagonal or four-sided crystalline columns or fibres, $\frac{1}{500}$th of an inch in diameter, and the fibres are so placed as to pass in a direction from the surface towards the centre of the tooth: by which all the friction to which the columns are exposed is applied against their extremities: an arrangement on the principle of the articular cartilages, and, like them, precisely suited to retard their being rubbed down in mastication, and also to prevent their splitting.

Fig. 143.



Hexagonal Prisms of Enamel, highly magnified, from the exterior part of the enamel of an embryo incisor tooth. Circular outlines were seen upon the free, transversely truncated extremities, which were presumed to be the outline of the nucleus.

The enamel column appears to be formed from a file of long prismatic cells, resembling those of certain shells, and having a diameter of $\frac{1}{5600}$th of an inch. Its course is wavy, and marked by numerous transverse striæ, thought by Retzius to come from the coalition of the walls of pre-existing cells, in forming the hexagonal prism. In the state of development there appears to be, according to the observations of Dr. Leidy, an oblique instead of a rectangular truncation of the enamel fibre at these striæ.[1]

Enamel consists principally of earthy constituents, with a very small

[1] Leidy, see Quain and Sharpey, vol. ii. p. 415.

proportion of gelatin. When immersed in a weak acid, its form is retained, but the slightest disturbance afterwards causes it to crumble down into a white pulp. When animals are fed upon madder, the color of the enamel is not affected;[1] though it may be changed by dyes applied externally, as exhibited by the inhabitants of the Pelew Islands, who by the use of plants turn it black, and by persons who chew tobacco, in whom it becomes yellow. It is entirely devoid of blood-vessels. When exposed to heat it becomes very brittle, cracks off from the enclosed part of the body, and presents a singed appearance, notwithstanding the small quantity of gelatin in it.

The enamel is separated from the ivory by an extremely fine membrane, which extends its processes outwardly, so as to form a thin organic sheath for each enamel fibre. This sheath is finally obliterated or nearly so, and the fibres thus consolidate.

The enamel is not so thick on the deciduous as on the permanent teeth; it is thicker on the cuspidati than on the incisors, and on the first molar than on the second and third. It is very readily dissolved in strong nitric or muriatic acid.

The ivory portion of the tooth, or Dentine (*dentinum, substantia*

Fig. 144.

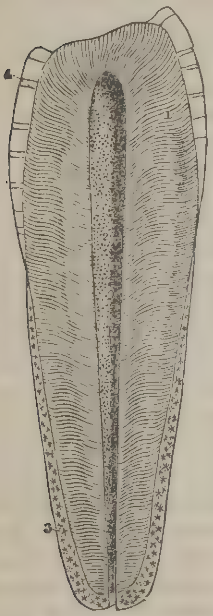


Fig. 145.

Fig. 144. Magnified representation, or rather diagram, of a Bicuspid Tooth divided longitudinally. 1. The ivory or dentine, showing the direction and primary curves of the dental tubuli. 2. The pulp-cavity, showing the orifices of the tubuli. 3. The crusta petrosa or cement covering the fang as high as the border of the enamel at the neck. The stars indicate that it contains lacunæ like those of bone. 4. The enamel resting on the dentine.

Fig. 145. Section of the Dentine made across the tubuli, highly magnified. 1, 2, 3. Dentinal tubes in transverse section, exhibiting their cavity and walls. 4, 5, 6. The tubuli obliquely cut.

[1] J. Hunter, loc. cit. I have also verified the same opinion by the same experiment.

propria), is by much the most abundant, as it forms the root, the neck, and the body also, with the exception of the crust of enamel upon it. Its texture strongly resembles the petrous bone, and is even harder than it.

When the dentine or ivory-like part of a tooth is examined microscopically in thin slices, it is found to be permeated by slightly bent cylindrical tubuli, close to one another, and running outwardly towards the surface of the tooth.[1] One end, and the larger of each canal runs into the cavity of the tooth; the other end ramifies with extreme minuteness, and seems to penetrate partially the enamel and the cement, but of this there is some doubt. The dental tubules have distinct parietes in the midst of the hard substance which invests them. Their course is waved, the longer curves presenting secondary curvatures. The parallelism and nearness of the tubules give to the dentine, under a low magnifying power, the appearance of being formed of concentric lamellæ, like a tree. In the living tooth they are said to contain a reddish fluid, but they are too small for blood-corpuscles,[2] as their diameter at the central end is only the $\frac{1}{10000}$th of an inch, or $\frac{1}{4500}$th, according to Retzius, while their ultimate branches are too fine for any measurement. Their outer end has its ramuscules terminating free or else by anastomosis with others, or in minute cells, or by small dilatations from which other ramuscules depart. Some are said to reach the lacunæ of the crusta petrosa. The minute cells of the dentine are but few in number, and exist principally near the enamel in a stratum which is called the granular layer of Purkinjé. The tubules serve probably for the conveyance of a nutritious fluid, elaborated from the blood of the pulp of the tooth. Müller and Owen are of opinion that they also contain calcareous matter.

The dentine of a tooth has very nearly the same form with the entire body; hence, upon the grinding surface, we have the same modifications of shape as when the enamel is left on. The enamel surface of the dentine is marked by undulating grooves and ridges, and also by hexagonal depressions, made by the attachment of the inner end of the enamel fibres. The application of a heated iron to it turns it to a deep black, from the abundance of animal matter in it, which is one way to mark out decidedly the distinction between it and enamel. The animal substance, when separated from the calcareous by muriatic acid, is more compact than the corresponding substance of bone, but, like it, is soft and flexible.

The dentine is not vascular; Mr. Hunter, after repeated trials in old and young subjects upon this point, never succeeded in making an injection of it; neither could he trace vessels from the pulp to a growing tooth. In growing animals, fed upon madder, he found that the portion which was formed previously to the commencement of this diet, retained its primitive color, while the part formed during the administration of the diet was affected by it and turned red: again, if the animal were permitted to live some weeks after the madder was sus-

[1] Owen's Odontography, p. iii. London, 1841.
[2] Gerber, Gen. Anat., page 198.

pended, to the preceding condition was superadded a new layer of white. In this experiment, a conclusive difference from common bone is established; for besides, in all cases, the facility of injecting the latter with size, it is susceptible of being dyed throughout by the administration of madder; though the formed parts do not take the latter so readily as the forming. These experiments, which are confirmed by my own observations, prove satisfactorily the total absence of blood-vessels in the texture of the dentine; and that the coloring matter, when fixed in them, does not depend upon a circulation, but upon its being deposited as the tooth grows, and left there permanently. The teeth are consequently not subjected to a mutation of particles, and to being continually remodelled as the bones are; but, when once formed, they remain in the same state, without change.

The Cement (*crusta petrosa*), bony, or cortical substance is an envelop to the substantia propria, or ivory, and extends from the margin of the enamel to the tip of the fang. Purkinjé and others have traced it as a thin lamella over the enamel, but it soon wears away there. There seems to be no difference between it and common bone, and it augments in quantity as life advances; in some individuals it is so exuberant as to make the fangs club-like. In the ruminantia it forms stratifications in the interior of the teeth, side by side with the enamel. As the teeth become worn in the progress of life a new barrier is presented against the exposure of the cavity by the deposit in it of this substance, which in some cases fills the cavity entirely. It undergoes there some modification of texture called *osteo-dentine* by Owen, and which permits blood-vessels, surrounded by Haversian canals as in bone.

Under the microscope, Purkinjean or bone-corpuscles are visible in the cement, and they are in layers concentrically disposed, but their radiations are smaller than those of common bone. Gerber asserts, that it is furnished with a few blood-vessels of considerable

Fig. 146.

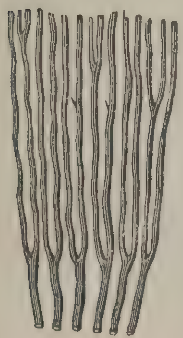


Fig. 147.

Fig. 146. A view of the most interior portion of the main tubes of the Dental Bone in an incisor of a child two years old, close to their commencement in the cavitas pulpæ, in order to show their first division.

Fig. 147. A view of the external portion of the tubes of the same Tooth, exhibiting their more minute ramifications, which, for the most part, turn towards the crown.

size, which run from the root outwards and towards the crown. As his comparative and human anatomy are much blended in his descriptions, he has not specified whether the arrangement exists in man or not.

According to Chemical Analysis, a Tooth consists of ingredients in the following proportions:—

	[1]Enamel, by Berzelius.	Dentine, by Berzelius.
Phosphate and Fluate of Lime,	88.5	64.3
Carbonate of Lime,	8.00	5.3
Phosphate of Magnesia,	1.5	1.0
Free Alkali,	1.00	0.0
Animal Matter and Water,	1.00	28.00
Soda and Muriate of Soda,	0.0	1.4

Cement, according to Lassaigne.

Phosphate of Lime,	53.84
Carbonate of Lime,	3.98
Animal Matter,	42.18

Every tooth has within its body a cavity (*cavitas pulpæ*), which varies in form and size according to the class to which the tooth belongs: this cavity, as mentioned, is continued as a conoidal canal, through the whole length of each root, and terminates by a small opening, at its point (see Fig. 144). The cavity is smooth on its internal surface, and is filled with a soft pulpy matter (*pulpa dentis*), which has no adhesion to the sides of the tooth, but receives, through the opening in the root, an artery, a vein, and a nerve. The surface of the pulp is moistened by a slight exhalation, and its principal bulk seems to be formed by the nerve, on which the vessels ramify; the latter in youth are much more abundant than in old age.[2] The base of each projection on the grinding surface of a tooth is hollowed out for receiving a process from the pulp. The latter is supposed, by M. Serres, to be a ganglion; it must, however, be a point of much difficulty to fix this character upon it, as the fine cellular substance which holds its constituents together may be readily mistaken for soft nervous fibres. The nerves are said by Valentin and Hannover to end in looped filaments. Acetic acid exposes many nuclei in the pulp.

The arteries of the teeth of the upper jaw are derived from the alveolar and the infra-orbitar; and the nerves from the second branch of the fifth pair. The arteries of the teeth of the lower jaw come from a single branch of the internal maxillary, and the nerves from the third branch of the fifth pair. The inferior maxillary, or dental artery, and nerve, go through the canal in the centre of the spongy

[1] The analysis of Bibra assigns to it 89.8 phosphate of lime with traces of fluoride of calcium; 4.4 carbonate of lime; 1.3 phosphate of magnesia and other salts, and 3.5 of animal matter.

[2] Serres, Essai sur l'Anat. et Physiol. des Dents, Paris, 1817.

structure of the lower jaw, and send off branches successively to the roots of the teeth. The residue of the artery and nerve issues through the anterior mental foramen.

The teeth have been very generally ranged among the bones belonging to the skeleton. This opinion, nearly at one time obsolete, has been latterly revived by the researches of the microscopical anatomists,[1] and they are now said to be modified or epithelial bones. The opposite authorities,[2] now perhaps somewhat disused on this point, are disposed to view them as the production of the dermoid tissue, like the nails and the hair, and to withdraw them from the class of bones; for the following reasons. The rudiments of the bones are always in a cartilaginous state, and they are gradually changed from that condition to the perfect bone; the teeth are never so, for the secretion which forms them is from the beginning deposited in the state in which it ever afterwards remains. The bones are all furnished with a periosteum; the teeth are not so fully, but have the surfaces of their bodies exposed to the air. The general softening of the skeleton which occurs in some cases of rickets, never is manifested in the teeth.[3] The texture of the bones is penetrated in every direction with blood-vessels, but only the central pulp of the teeth is furnished with the latter. The teeth are composed of two kinds of calcareous matter, one osseous, the other enamel; the bones, on the contrary, have but one.[4] To this we may add, that the teeth have no power of interstitial growth like the bones. It is also said by naturalists that, in mammiferous animals, the teeth present insensible transitions from their most perfect state to a lamellated condition resembling horns and nails.[5] Some animals, as the shark, have the teeth only adhering to the gum and not fixed in sockets; others have them in the stomach; both of which circumstances serve to illustrate still farther the independence of the teeth upon the osseous system; and that their being fixed in sockets belonging to the latter, is merely a collateral and not an essential arrangement.

In irregular dentition in the human subject, teeth are sometimes found growing from the roof of the mouth without a direct attachment to the bone; and cases occur where teeth being abandoned by the sockets, take a transverse horizontal position to the gum, adhering only to it, and having the length of one side, the upper or free, exposed. In the anatomical cabinet, there is a tooth of full size, having no other matrix, but an encysted ovarium. These instances prove unequivocally, the intrinsic independence of the teeth upon the skeleton, whatever may be the analogies of composition and texture.

[1] Miescher, Müller, Retzius, Nasmyth, Owen, and Gerber.

[2] J. F. Meckel, Hipp. Cloquet, Breschet, Serres, &c.

[3] There is, however, a species of brittleness of the teeth, in which their strength becomes about that of pipe-clay.

[4] Serres, loc. cit.

[5] Traducteurs de J. F. Meckel, Paris.

SECTION III.

The Gums (*gingivæ*) are a continuation of the lining membrane of the mouth over the alveolar processes, but its texture there is much changed ; as it becomes more fibrous, very vascular, and loses much of its sensibility and capability of being extended. As the gums cover both the lingual and the buccal semi-circumference of the alveolar processes, they adhere very closely to the periosteum, and send in partitions through the interstices between the teeth. They also adhere tightly to the neck of each tooth, so that, when the latter is drawn, the gum, unless previously detached, is apt to be lacerated ; this adhesion is by a sort of rounded or partially doubled edge, that admits of a slight degree of motion, and which, from its thickness, if it be removed, by ulceration or by pressure, causes the tooth to appear to project unnaturally from its socket. The teeth, from being united to the jaw by the gum, and by the periosteum continued over the cavity of the socket, have preserved to them that degree of yielding motion which prevents them, on their unexpected and forcible application to hard bodies, from being fractured, and also saves their sockets.[1]

SECT. IV.—OF THE EVOLUTION OF THE TEETH.

The teeth, before they protrude, are formed in the interior of the maxillary bones.

Fig. 148.

Part of lower Maxilla of a child, containing all the milk teeth of the right side, and the incisors of the left. Sacs and pedicles of the permanent teeth (except the wisdom tooth), exposed by removing part of the bone on the inside. The alveolar canal also laid open to show the course of the nerve. The large sac near the ramus of the jaw is that of the first permanent molar ; and above and behind it, is seen the commencing rudiment of the second molar.

In that condition, their matrix or rudimental state is represented by a vascular pulp, surrounded by two sacs, an external and an internal one. The pulp adheres firmly around its base to the sacs, and is the source of the dentine.

[1] J. Hunter, loc. cit.

The *External sac* is soft, fibrous, and spongy, and, according to Mr. Hunter, is destitute of vessels. It lines the interior of the socket, thereby forming its periosteum;[1] adheres closely by its deepest end to the dental nerves and blood-vessels, and by its superficial one to the cartilaginous thickening which exists upon the margin of the gums of infants. Fox, Blake, and Meckel consider this sac vascular, which I think more probable, from its being a continuation of the periosteum, or acting as such. Mr. Hunter might, therefore, mean that it was comparatively destitute of vessels, and not totally. It is more spongy, loose, and soft than the internal sac, and owing to its adhesion to the gum, may, by pulling at the latter, be readily drawn out entire with all its contents. The *Internal sac* is extremely vascular, and when successfully injected appears red all over; it is very thin and transparent, and was considered by Bichat as a serous membrane. The internal sac, at its region next to the gum, has a pad or velvety surface, the source of the enamel; and at the other end, and contiguous region, a granular surface, from which is produced the cement. It adheres to the external sac where the latter corresponds with the gum; but is elsewhere detached from it with the exception of its base, where it is united by the medium of the vessels that penetrate to the pulp, and in doing so it obtains its extreme vascularity from these vessels. Between it and the pulp there is a mucilaginous fluid like the synovia of the joints,[2] which causes the internal sac to protrude like a hernia, if a small puncture be made through the parietes of the external one. The internal sac forms an envelop to the vessels and nerves of the pulp, and being reflected along them, terminates by adhering to the base of the pulp. When the tooth protrudes through the gum, the capsule thus formed by the two sacs is perforated at its summit; and wastes away like the gum, till the body of the tooth is sufficiently advanced. The two capsules, which are then to be considered as the periosteum of the socket and of the root of the tooth, adhere closely to the neck of the latter and to its root. These sacs, or follicles, as they are sometimes called, are visible in the tenth week, or earlier, of uterine existence.

The Pulp, or germ of the tooth (*pulpa dentis*) is a very vascular body, and adheres to the socket only at its bottom, where the vessels enter; it becomes sufficiently distinct in the fourth month of fœtal existence, and rises up then from the base of the internal membrane of the sac like a small simple tubercle. In developing itself it acquires the form peculiar to each tooth, and is actually the mould for it: it is surrounded by a very fine vascular web, the *Membrana preformativa* of Purkinjé, which is detached from it with much difficulty.

The *Ossification* of a tooth first commences on that surface of the pulp next to the gum, by one or more points according to the number of projections which the future tooth is to have on its grinding surface. The osseous formation in its very early stage is thin, soft, and elastic, but soon acquires a hard consistence. The incisors begin to ossify by

[1] Serres, loc. cit. [2] Hunter, loc. cit.

three points, the cuspidatus by one, the bicuspis by two, and the molaris by three, four or five. The several points of ossification continue to increase till their bases come into contact; they then coalesce, and afterwards the tooth grows as an entire body. The triturating surface of the tooth being first laid after this manner, a formation of bone then takes place along its edges, till the body of the tooth, with the cavity in the centre, is completely built up. In this progress, it gradually surrounds the pulp, till the whole of the latter, excepting its base, is covered with bone.

The adhesion of the pulp to the new-formed bone is such as to require some slight force to separate them; but this may be done without rupturing materially either the one or the other; their surfaces which were in contact are smooth, neither is there any evidence of a vascular communication between them.[1] The line of the strongest adhesion is along the latest formed edge of the tooth, and that results from the exact apposition of the pulp and it.

The crown or body of the tooth being finally finished, its base is somewhat contracted, and thus forms the neck of the tooth. In the subsequent process of the ossification of the root, the number of the latter is predetermined and always indicated by the number of distinct vessels and nerves which go to the pulp; there are, therefore, three roots to the upper molares, two to the lower, one to the incisors, and so on. When the root is fully formed, its extremity is tapered off to a conoidal point; and the canal or hollow in it containing the pulp is diminished to a proportionate size, so that being also conoidal, its external end appears as a very small opening not large enough to admit a bristle.

"Both in the body and in the fang of a growing tooth, the extreme edge of the ossification is so thin, transparent, and flexible, that it would appear to be horny rather than bony, very much like the mouth or edge of the shell of a snail when it is growing; and, indeed, it would seem to grow much in the same manner, and the ossified part of a tooth would seem to have much the same connection with the pulp as a snail has with its shell."[2]

From the preceding account, it is clear that the ivory part of the tooth is formed from the external surface of the pulp; consequently, that the external lamina of the crown is the first one deposited, and is originally of the size which it ever afterwards retains; and that the pulp continues this elaboration of matter, from the circumference to the centre, until the tooth (body, neck, and root) is completely formed. The pulp, during this process, diminishes continually in size, but elongates itself at the same time towards the bottom of the socket; or, in the words of Mr. Hunter, "is lengthened into a fang."

As the fang grows in length, the resistance being at its end, causes the tooth to rise through the gum; the socket, in the mean time, has grasped the neck, or beginning fang, and, being modelled upon the root, arises with it. Mr. Hunter's experiments on animals, interruptedly fed on madder, led him to believe, that the ivory part of a tooth is formed

[1] Hunter, Serres, Meckel, loc. cit.
[2] Hunter, Nat. Hist. of Human Teeth, p. 90.

of lamellæ, one placed within another; that the outer lamella, being first formed, is consequently the shortest, and that the internal ones lengthen successively; this appearance is now, however, attributed, by Mr. Owen, to the secondary curves in the dental tubules.

In the formation of a molar tooth, when the body is finished, ossifications shoot from its brim, and proceed to the centre, where, by their union, they form the commencement of two, three, or occasionally more roots. Mr. Hunter says, that also a distinct ossification is frequently found upon the centre of the base of the pulp; and two or more processes, according to the number of roots to be formed, proceed to join it from the circumference of the tooth; and in this way the fangs of the multiform teeth begin.

The formation of enamel begins shortly after the external laminæ of the bony matter commence being deposited. This material, which has its mould always previously formed of the ivory part, comes from the velvety pad adhering to the inner face of the internal capsule. The velvety pad or pulp, by its place on the part of the capsule nearest to the gum, faces the pulp which secretes the bone; whatever eminences the one pulp has, the other has the same, but reversed, so that they exactly fit upon each other. This pulp is best seen in the fœtus of seven or eight months, and is not very vascular;[1] it is much thinner than the other, and decreases in size as the development of the teeth advances. That which belongs to the incisor teeth is in contact with their concave interior surface, but in the molar it is opposed to their biting surface.[2]

"In the graminivorous animals, such as the horse, cow, &c., whose teeth have the enamel intermixed with the bony part, and whose teeth, when forming, have as many interstices as there are continuations of the enamel, we find processes from the (enamel) pulp passing down into those interstices as far as the pulp which the (bony) tooth is formed from, and there coming into contact with it.

"The enamel appears to be secreted from the pulp above described, and perhaps from the capsula which encloses the body of the tooth. That it is from the pulp and capsula, seems evident in the horse, ass, ox, sheep, &c.; therefore, we have little reason to doubt of it in the human species. It is a calcareous earth, probably dissolved in the juices of our body, and thrown out from these parts, which act here as a gland. After it is secreted, the earth is attracted by the bony part of the tooth, which is already formed; and upon that surface it crystallizes.

"The operation is similar to the formation of the shell of the egg, the stone in the kidneys and bladder, and the gall stone. This accounts for the striated crystallized appearance which the enamel has when broken, and also for the direction of these striæ.

"The enamel is thicker at the points and bases than at the neck of the teeth, which may be easily accounted for from its manner of formation; for if we suppose it to be always secreting and laid equally over the whole surface, as the tooth grows, the first formed will be the thickest; and the neck of the tooth, which is the last formed part enclosed in this capsula, must have the thinnest coat; and the fang where

[1] Owen denies that it has any capillaries.

[2] Hunter, loc. cit.

the periosteum adheres, and leaves no vacant space, will have none of the enamel.

"At its first formation it is not very hard, for, by exposing a very young tooth to the air, the enamel cracks and looks rough; but by the time that the teeth cut the gum, the enamel seems to be as hard as ever it is afterwards; so that the air seems to have no effect in hardening it."

The preceding passages have been extracted literally from the celebrated J. Hunter's Natural History of the Human Teeth, not only on account of their graphical value, but to fix upon him the merit of having first considered the human teeth as a secretion; an opinion the originality of which is falsely attributed to the Baron Cuvier, by M. Serres.[1]

In opposition to this, which is now called the *Excretion Theory*, there is presented the *Conversion Theory* founded upon the recent observations of Schwann, Purkinjé, Raschkow and of Owen. Under the latter doctrine we have to view the Dentine as formed from the real conversion of the pulp, by the pulp being actually calcified, after the manner of bone cartilage. The pulp, to produce this result, must of course undergo a continued growth and series of metamorphoses, which are explained as follows. The pulp consisting, as it does, of minute nucleated cells, with capillary blood-vessels and nerves terminating in loops, is invested by a dense structureless membrane (*membrana preformativa*) which disappears during the formation of the dentine. The peripheral cells are elongated in a line with the dental tubules, and are found by the microscope in a state of transition into dentine; when the pulp and the surrounding surface of dentine are forced apart, these transition cells are found adhering to the latter.

According to Prof. Owen, the first calcification takes place in the interior of the nucleated cells, and about their nuclei, which are split up and form by their elongation a connection with the nuclei in advance of them. The divided nuclei become secondary cells, and being placed in files or rows, remain uncalcified, and constitute the tubuli of the dentine. The sum of this theory, then, is that the dentine consists of the calcified cells of the pulp—and the tubules are the nuclei uncalcified, and which have formed a linear connection with one another.

Upon detaching a layer of the calcified cells, the exposed surface of uncalcified pulp resembles a net-work, the meshes of which are formed by the cells themselves and by the intervening blastema. Each mesh is filled by a finer net-work, the centre of each loop of which was continuous with the tubules of the dentinal substance.[2]

The matrix or pad of the internal capsule, from which originates the enamel, is at first in a more fluid state in regard to its blastema, and has fewer and more minute cells, but in progressing towards the dentinal pulp it acquires more consistence; and has cells of augmented volume, some of which have a nucleus and even a nucleolus. The free surface of this structure is coated by a fine transparent membrane, upon which rests a thick stratum of nucleated cells, composing the enamel

[1] Anat. et Phys. des Dents, p. 63.

[2] Odontography.

membrane (*membrana adamantina*). The vascular part of the enamel pulp sends forward villous processes containing blood-vessels, which project into the enamel membrane opposite the grinding surface of the tooth. The cells by mutual pressure are elongated and forced into hexagonal and polygonal forms, the blastema between them being almost excluded. The cells finally lose all trace of nucleus and become elongated prismatic filaments, which imbibe the calcareous matter from the blastema, and form themselves into a clear and almost crystalline state in their interior. As a final action, the membranous walls of the cells disappear, except next to the enamel pulp. In opposition to the reputed vascularity of the enamel membrane, Mr. Owen says that no capillaries exist in the enamel pulp, the cells of the latter must, therefore, have an inherent power of their own in producing such changes, by a selection of material from the internal capsule of the dental sac.[1]

The transverse striæ of the human enamel, it is suggested by Prof. Owen, are due to the remains of nucleoli.

The matrix of the Cement or Crusta Petrosa of the tooth consists of a granular blastema upon the interior face of the inner dental capsule; this matrix is furnished, according to Mr. Owen, with nucleated cells, and copiously supplied with blood-vessels. The process of calcification begins on its free surface next to the dentine, and consists in the introduction of calcareous matter into the cavities of the cells, and in their closest aggregation. The newly-formed cement presents on its surface small depressions made by the contiguous unossified cells. The nucleus of a cell is large, granular, and almost fills the area of the cell, and as the process of calcification advances, the nucleus, not participating in the latter, sends out radiating prolongations. This disposition of the nuclei, when the latter are removed, causes the microscopic analogies as to the corpuscles of Purkinjé between bone and cement.

In infants, for several months after birth, the biting margin of the gums upon each jaw is faced by a cartilaginous rising of some lines in elevation, and divided by slight fissures. Its usual appellation is that of Dental Cartilage (*cartilago-dentalis*); it performs the function of teeth, in retaining the nipple, and in mastication, and is analogous to the horny beak of birds, and of some reptiles; it only disappears upon the protrusion of the teeth. In the upper jaw it is about three lines wide, and in the lower about two. If it be removed by thin slices, successively made, till the margins of the alveoli appear, one arrives by that means at the ends of the dental follicles or sacs; from which it appears that there is no intermediate substance.

In the preceding cartilage are found many small glands, grouped about in different parts of it. They were discovered by M. Serres,[2] of Paris; are about the size of a millet seed, contain a whitish fluid, and when examined by the aid of a microscope do not appear to have any distinct opening or duct, in consequence of which they must be punctured in order to expel their contents. The largest of them are on the internal side of the gum near the molar teeth.

[1] Odontography. [2] Loc. cit.

According to their discoverer, these glands serve to lubricate the dental cartilages of the infant, but after the protrusion of the teeth they secrete the substance commonly called tartar, and heretofore falsely attributed to the saliva. Their secretion being of a fatty nature, keeps up the high and brilliant polish which the teeth have till middle age; it being afterwards altered, the teeth then become more dull and yellow. Salivation produces an excessive secretion and deposit of tartar from these glands. J. F. Meckel states that he has never been able to discover them till towards the period of dentition, from which he is rather induced to consider them as a morbid production depending upon irritation, and probably not differing from little abscesses.

According to Mr. Mandl, the tartar, heretofore considered as a simple calcareous concretion deposited on the teeth, is a mass of calcareous skeletons of Infusoria, agglutinated by dried mucus. The animals are of the description called Vibrios, and are formed in a living state in the mucus of the mouth, especially after fasting. They are said to make a large part of the mucous covering of the tongue in dyspepsia.

SECT. V.—PHENOMENA OF DENTITION.

Infants have a set of teeth called Deciduous, from their being lost after a certain period of time. Their whole number is twenty, ten in each jaw, consisting on either side of two incisors; one cuspidatus; and two molares, having a shape corresponding with that of the large grinders in the adult. Several of these teeth fall out about the seventh year, and all of them have disappeared about the fourteenth. The time of their first protrusion through the gums is variable, but may, as a general rule, be stated at from the sixth to the eighth month after birth. They appear commonly in pairs. The pairs of the lower jaw have precedence in their protrusion; and are immediately followed, successively, by their congeners in the upper. The order of protrusion is as follows:—

The two central incisors, from the sixth to the eighth month;

The two lateral incisors, from the seventh to the tenth month;

The first molar tooth, on each side, from the twelfth to the fourteenth month;

The cuspated, from the fifteenth to the twentieth month;

The second molar, on each side, from the twentieth to the thirtieth month.[1]

The average time may be stated as follows:—

Central incisors, seventh month;

Lateral incisors, ninth month;

First molar, twelfth month;

Cuspate, eighteenth month;

Second molar, twenty-fourth month.

The Deciduous teeth, by a process which will be presently explained, drop from the gums and are succeeded by the permanent teeth. The

[1] Serres, loc. cit.

first permanent molar, by emerging behind the second infant molar, at about six or seven years of age, leads the way to the second epoch of dentition which occurs in the following order:—

The central infant incisors fall out about the sixth or seventh year, and are immediately followed by the central permanent incisors;

In a few months afterwards, sometimes at the same period, the lateral infant incisors tumble out, and are succeeded by the lateral permanent incisors;

About the ninth year the first molar teeth fall out, and are succeeded by the first bicuspated;

From the ninth to the eleventh year the second molars fall out, to be succeeded by the second bicuspated;

From the eleventh to the twelfth, the infant cuspated are followed by the adult cuspated;

About the end of the twelfth year, the second permanent molars protrude behind the first permanent;

And, finally, about the twenty-first, or in cases from the sixteenth to the twenty-fifth year, the third permanent molars, or the Dentes Sapientiæ, make their appearance.

In the jaw of a fœtus of three or four months after conception, the beginning of the alveolar processes may be observed, in the condition of a longitudinal groove, deeper and more narrow in front, more shallow and wider behind; and in the bottom of the groove are small transverse ridges, dividing it into superficial depressions. From this simple condition, ridges begin to shoot out from the opposite sides of the canal near its brim; and form, by their junction, arches across it; more matter being added to these arches, they make, in their progress, a sort of cell for each tooth, open on its alveolar surface. This opening is nearer the internal circumference of the alveolar processes, so that the teeth are almost covered, and probably for the reason advanced by Mr. Hunter, that the gums may be firmly supported before the teeth come through.

The rudiments of the teeth which are earliest in their appearance may be readily found in a fœtus of two or two and a half months; and at the expiration of three months, it is said that all the germs of both sets of teeth exist in a manner to be distinguished.[1] The germs of this period are lodged in membranous folds belonging to the gum. The germs of the first dentition are immediately attached to the gum, while those of the second are suspended by pedicles or gubernacula of a line or two in length, which circumstance alone permits them to be distinguished. At four months all the germs are contiguous to each other, with the exception of the incisors; shortly afterwards they begin to be separated by the rudiments of the alveolar processes; and about the fifth month ossification is perceptible in the infant incisors, and goes on in the other teeth very much in the order of their appearance.

The germs of the deciduous teeth are placed in an arc of a circle, the cuspidati being thrown forwards out of the line of the others and

[1] Serres, p. 3.

somewhat lower; in consequence of which, the small molar or bicuspate border closely upon the incisors. The germs of the permanent teeth are brought into view by removing the internal face of the jaw, and are at the posterior upper side of the first germ, being, therefore, nearer to the edges of the alveolar processes.

The matrix or rudiments of the permanent tooth are, according to Meckel, the offset from the corresponding deciduous tooth.

At birth, ossification has taken place in all the infant teeth, though their roots are not yet completed. The rudiments of the permanent teeth, though seen at an early period of fœtal existence, do not begin to ossify till after birth. Thus, the first adult incisor and molar begin to ossify about the fifth or sixth month of life, the second incisor and cuspidatus about the ninth month, the first bicuspis about the fifth year, the second bicuspis and second molar about the sixth or seventh, and the third molar about the twelfth year.[1]

The preparation for the evolution of the teeth, according to the observations of Mr. Goodsir,[2] is visible at the sixth week of fœtal life, in the upper jaw by a deep narrow groove which is speedily divided into two by a narrow ridge. The outer groove is to become in progress of time the outer alveolar processes; while the inner groove is the nidus for the evolution of the teeth. In the seventh week a small ovoidal papilla of granular matter, the rudiment of the first milk molar, is seen: in the eighth week a similar evolution for the canine takes place; in the ninth week the process is repeated for the incisors, and in the tenth week for the second milk molar. The sacs or follicles of the teeth are formed originally by processes crossing the dental groove and finally coalescing so as to cover in and around the papilla. In the thirteenth week the rudiments consist evidently of a vascular pulpy substance, and is surrounded by a double capsule. This Mr. Goodsir calls the follicular stage, and is completed in the fourteenth week.

In the fourteenth or fifteenth week the original dental groove is raised to a higher level than before; that is to say, deepened, and in that state being called the secondary dental groove, it gives origin to the second set of teeth by the evolution of small compressed sacs between the gum and the first set of germs, to the follicles of which they adhere by a species of gemmiparous attachment. There are stages of evolution and transposition from this period to the perfect state of dentition[3] which are too much in detail to be inserted here, but which may be advantageously studied in the paper alluded to.

The observations of Mr. Goodsir have, in many respects, been essentially confirmed by Professor Owen, in his celebrated work.[4] The latter says, that the first papilla may be distinctly recognized in the maxillary mucous groove of a human embryo of one inch in length. This papilla or dentinal pulp is the first developed part of the rudiment or matrix, and by the growth of the contiguous mucous membrane, has a sort of follicle formed around it, the orifice of which is finally closed by three

[1] Hunter, loc. cit.

[2] On the Origin, &c., of the Human Teeth, Edinburgh Med. and Surg. Journal, January, 1839. See, also, Principles of Human Physiology, by W. B. Carpenter. London, 1842.

[3] Ibid., Quain and Sharpey, Anat. Phila. 1849.

[4] Odontography, London, 1840.

or four lamellar plates forming an operculum. Upon the interior face of these plates, and upon the adjoining region of the capsule or follicle, the enamel pulp is developed at the sixteenth week.

As the permanent teeth are preparing to protrude, the alveolar cavities, in which they are contained, form orifices on the internal surface of the jaw near the edges of the deciduous alveolar processes, and which are called the Alveolo-dental Canals (*itinera dentium*). Those for the incisor and canine teeth are just behind their corresponding deciduous teeth, and those for the bicuspated near and somewhat behind the infant molares. At this period, a bony septum separates almost completely the two orders of alveolar cavities from each other, and thereby prevents their mutual interference or communicating.

The teeth which have no predecessors are, in consequence of their adhesion to the gum, brought out in their regular places; but, in the case of such permanent teeth as take the position occupied by the deciduous, there is, before the tooth protrudes, the pedicle already alluded to (*gubernaculum dentis*), which passes from the alveolar end of the sac of the permanent tooth to the sac of the deciduous tooth; and even when the latter is fully formed and protruded, the same pedicle may be traced to that part of the gum surrounding the neck of the deciduous tooth.[1] At birth, the rudiments of fifty-two teeth may be found in the two jaws; and, as a general rule at that period, the rudiments of the permanent are more superficial than those of the deciduous; but their position is subsequently changed, so that the first descend while the latter ascend.

The permanent teeth being thus formed in new and distinct sockets, and being kept off from the deciduous, it is clear that the latter cannot be pushed upwards out of their alveoli, as is sometimes supposed, by the growth of the former; and if it did take place, it would produce the great inconvenience of causing them to rise up into the mouth, beyond the level of the other teeth. On the contrary, the deciduous teeth are made loose by the removal of their roots, which progresses till nothing but the neck is left, and then the slightest force applied dislodges them from their position on the gum. This decay of the root is not even affected, according to Mr. Hunter, by the pressure of the rising tooth, for the new alveoli rise with the new teeth, and the old ones decay along with their decaying fangs; and when the first set falls out, the succeeding teeth are enclosed by a complete bony socket; from which it is evident that the change is not produced by mechanical pressure, but is a particular process in the animal economy.[3] In farther proof, however, Mr. Hunter has seen two or three jaws where the second deciduous molars were shedding by the decay of their roots, without there being underneath any tooth to press upon them; and in another jaw he observed the same circumstance in both molars on each side. In a female patient, in whom the last temporary molar was loose, and was pulled out in consequence, it was not succeeded by another tooth. One of these patients at the time was aged twenty, and the other thirty;

[1] Cloquet, Anat. Pl. XXII. fig. 16, 17. Serres, loc. cit. p. 109.
[2] Serres, loc. cit.
[3] Hunter, loc. cit.

from which it would appear, that though the wasting of a fang of a deciduous tooth does not depend upon the pressure of the permanent one, yet the latter determines, in some measure, its expulsion, as without some such influence, the period of shedding would not have been so late.

From these observations of Mr. Hunter, it is established that the pressure of the permanent tooth is not indispensable to the removal of the deciduous one in all cases; yet I think it will be most frequently found that much of the decay of the root of the deciduous tooth is owing to its being absorbed by the pressure of the body of the permanent one. The alveoli of the latter teeth, judging from my own observations, are seldom so perfect towards the period of their protrusion as to form a complete separation of the two orders of teeth. And even when the alveoli are perfect, the permanent tooth is made to press upon the root of the deciduous tooth by the evolution of the body of the permanent, of which pressure the root of the deciduous exhibits ample evidence.

Besides the deciduous teeth being loosened, as stated by Mr. Hunter, by the absorption of their alveolar cavities while the fangs are disappearing, the following process occurs. The permanent teeth protrude within the circle of the deciduous, the arch of the latter is weakened, and its several pieces are in that way detached by a force acting from within outwards: this influence being much assisted by the wasting of the alveolar cavities, which proceeds principally at their outer circumference. The latter, however, is not so obviously the case with the molar as with the incisive and canine teeth.

The deciduous teeth, even before they are loosened by the absorption of their fangs and of their alveolar processes, are much more easily extracted in proportion than the adult teeth, from the texture of their periosteum being much softer and more yielding.

In the lower jaw of the adult there is but one arterial trunk, which supplies the teeth; but, in the fœtus, and till the age of six or seven years, there are two arteries,[1] and as many canals for containing them. The lowest of these arteries belongs, exclusively, to the deciduous teeth; it is distinctly visible in the fœtus, augments till the third or fourth year, afterwards it shrinks, and is obliterated about the sixth or seventh year. In some rare cases its canal remains open for a longer time, as M. Serres has met with it in a woman of thirty. Being a branch from the inferior maxillary, it enters the bone at a foramen somewhat lower down than the posterior maxillary or mental; and what remains of it after the teeth are supplied comes out at another aperture, a little below the anterior maxillary foramen, and there anastomoses with the other dental artery.

M. Serres supposes that this artery, discovered by himself, and obviously serving in the evolution of the deciduous teeth; by being obliterated before they fall out, destroys their vitality, and, thereby, they become absolutely foreign bodies, the expulsion of which is required by nature on common principles.

[1] Serres, loc. cit. p. 17.

SECT. VI.—OF IRREGULARITIES IN DENTITION.

This process in certain individuals is premature; Louis XIV. was born with two teeth; many instances of the same sort of precocity are recorded by Haller and other medical writers, in some of which even ten teeth were found protruded at birth.

On other occasions, the process is retarded in a manner equally striking, and varying from the tenth month to the sixth or seventh year. This unusual tardiness is sometimes manifested in particular teeth; thus, I knew a gentleman in whom one of the permanent incisors of the upper jaw did not come down before the fourteenth year. Borelli reports a woman in her sixtieth year who never had teeth; a magistrate of Frederickstadt lived to an advanced age, and never had either canine or incisor teeth; he was, however, furnished with molares.

The teeth are sometimes supernumerary; it is not very uncommon to see this manifested by a single canine or incisor, and more frequently in the upper jaw than in the lower. Occasionally, there are several supernumerary teeth.

Cases are recorded in which several teeth have been fused or joined together. Bernard Gengha reports, that in a pile of bones belonging to the Hospital S. Esprit, at Rome, he found a cranium in which there were only three teeth, in the two upper maxillæ; one occupied the space of all the incisors and the two cuspidati; and each of the others the space of all the molares of its respective side.[1] According to the historians Plutarch and Valerius Maximus, Pyrrhus, king of Epirus, and Prusias, king of Bithynia, had a single dental piece in each jaw, which stood in the place of the usual allowance of sixteen teeth. These two cases are scarcely credible, for the reason, that for them to have occurred, the middle palate suture, which is slow in forming, and divides the germs of the two sides from each other, could not have existed during the fœtal state, at any time subsequent to the third month; or what is more compatible with this account, at no time whatever, from the two bones being consolidated, synostosed from the beginning. It is more probable, therefore, that notwithstanding the royal opportunities of cleanliness possessed by these distinguished persons, their teeth were neglected and permitted to encrust themselves with a dense, thick coat of tartar, which gave them the appearance of a single piece: a circumstance which occurred to Sabatier, in a girl of fifteen or sixteen, and to Fournier in an individual of the same age and sex.[2] Another objection is, that as the common law of the germs is to develop themselves, and to ossify at different epochs, in these two cases they were all not only proceeding at the same rate, but also joining one another so as to form but a common sac, confounding, thereby, all the known phenomena of dentition.

In most persons there are but two sets of teeth; it has happened, however, in several instances, for individuals about the age of seventy to have one or more new teeth belonging to a third set: they were com-

[1] Sabatier, Anat. tome i, p. 78.

[2] Dict. des Sc. Med.

monly incisors. J. Hunter saw an example of the kind.[1] The Countess of Desmond, who lived to her hundred and fortieth year, had at this period, according to Bacon, a third set of teeth.[2] Mentzelius narrates a similar case[3] in the following words: "Having accompanied the Elector of Brandenburg on a visit to Cleves, in 1666, there arrived, at the same time, a man aged one hundred and twenty, who exhibited himself for money, and whom I saw at the court of the Elector. His strength of voice manifested that of his breast, and he having run over the gamut, was heard at more than a hundred paces off. Having then opened his mouth, he showed us two rows of pearly teeth, and on the subject of their beauty related 'that being at the Hague two years before, on the same errand which brought him to Cleves, there arrived an Englishman aged one hundred and twenty;' that he visited the latter and addressed him in the following terms: 'We are nearly of the same age, for I am only two years younger than you, and I have had the greatest desire to see one older than myself, for I have felt no inconvenience till lately; but during the three days that I have been here, I have had severe headache and dreadful pains in the jaws, which convince me that I am about to die.' 'You are mistaken, my dear friend,' said he to me; 'on the contrary you are becoming younger, for you are about to teeth again like an infant.' 'Oh!' answered I, 'I pray to God not to punish me by prolonging my days.' 'I left him then and went to bed, and immediately after felt the most excruciating pains in the jaws, which were followed by the protrusion of the teeth that you now see.'"

The circumstance of a third dentition has given rise to a question among physiologists, whether the germs are primarily supernumerary? or whether the gums have within themselves organs capable of forming and of producing new teeth?

When such teeth come out in a straggling manner, they hurt the opposite jaw, and require to be extracted.

In old persons who have lost all their teeth, there is a cartilaginous hardening of the gum, as in infancy, whereby they still retain some power of mastication.

When the body of the tooth has been worn away, nature prevents the exposure of its cavity, as mentioned before, by the deposit of new matter from the pulp in the interior, a Crusta Petrosa or Cement (*osteodentine*), which may be known by its darker color, and by its transparency.

The muscles of mastication being the Temporalis, the Masseter, the Pterygoideus Internus, and the Pterygoideus Externus, their description may be seen elsewhere.

[1] Loc. cit. p. 85.
[2] Hist. vit. et mort. Col. 536.
[3] Serres, loc. cit. p. 40.

CHAPTER III.

OF THE TONGUE.

THE Tongue (*lingua*) is the principal organ of taste, and is also concerned in mastication and in speech. It is an oblong, flattened, symmetrical, muscular body, which extends from the os hyoides posteriorly to the incisor teeth anteriorly, and, being placed at the bottom of the mouth, fills up the space within the two sides of the body of the lower jaw. The exact extent of room which it occupies varies according to its being in a state of repose or of activity.

The posterior extremity of the tongue is called its base or root, and arises muscular from the body and the cornua of the os hyoides; it is there considerably thinner than elsewhere, it also has a fibro-muscular origin from the centre of the epiglottis cartilage; sometimes a cartilage is found in the middle of the base, and which forms a sort of ball and socket joint with the os hyoides. Its anterior extremity is called the tip or point, is loose, and has a rounded thin termination. Between the point and the base is the body. The superior surface of the tongue

Fig. 149.

The Tongue with its papillæ.—1. The raphe, which in some tongues bifurcates on the dorsum of the organ, as in the figure. 2, 2. The halves of the tongue. The rounded eminences on this part of the organ, and near its tip are the papillæ fungiformes. The smaller papillæ, among which the former are dispersed, are the papillæ villosæ and filiformes. 3. The tip of the tongue. 4, 4. Its sides, on which are seen the lamellated and fringed papillæ. 5, 5. The V-shaped row of papillæ circumvallatæ. 6. The foramen cæcum. 7. The mucous glands of the roots of the tongue. 8. The epiglottis. 9, 9. The fræna epiglottidis. 10, 10. The greater cornua of the os hyoides.

(*dorsum*) is flat, is divided by a middle longitudinal fissure of inconsiderable depth into two equal parts, and is covered by the lining mem-

brane of the mouth, under a particular modification of structure. The inferior surface of the tongue, with the exception of its middle part, is also free, and covered by the common mucous membrane of the mouth; but the latter is there very thin, and the veins may be readily seen shining through it.

The central plane of the tongue has a very thin vertical plane of yellow elastic ligamentous matter (*septum linguæ*), marking its two halves from each other, and affording a surface for the insertion of muscular fibres. It is an extension of the fibrous matter attaching the base of the tongue to the os hyoides, but is more dense in its structure.[1]

SECT. I.—MUSCLES OF THE TONGUE.

The muscles which compose the principal part of the bulk of the tongue, are, the Stylo-glossus, the Hyoglossus, the Genio-hyoglossus, and the Lingualis. As these, besides belonging to the general muscular system, also form so important a part of this organ, with a view of collecting the account of its structure, their description will be repeated.

1. The Stylo-glossus arises from the styloid process of the temporal bone, and soon reaches the side of the base of the tongue. Some of its fibres extend to the tip and confound themselves with those of the superficial lingual muscle, above and below the lateral margin of the tongue: while others form a broad transverse fasciculus, which is united to the corresponding portion of the other side in the region of the greater papillæ.[2]

2. The Hyoglossus arises from the side of the base of the os hyoides, from its cornu; and from its appendix, in a slight degree. It is placed within the stylo-glossus, and extends forwards to the tip of the tongue. Some of its fibres go as far as the middle line of the tongue; others rise almost perpendicularly upwards at its base; while the remainder are confounded, along the margin of the tongue, with the superficial lingual muscle.

3. The Genio-hyoglossus arises from the tubercle on the posterior face of the symphysis of the lower jaw, and immediately after its origin spreads itself after the manner of a fan. Its inferior fibres are inserted into the base of the os hyoides, while the remainder, by their diverging, are inserted into the whole length of the tongue from its base to its point. This muscle is in contact, side by side, with its fellow, and there is a sort of fissure with a small quantity of adipose matter between them.

As the fibres of this muscle go from below upwards, they penetrate

[1] Mr. Baur has described a cartilaginous lamina beginning at the point of the tongue and going back to its base; it is said to be found along the inferior surface of the organ.—*Cruveilhier*, *Anat.*, vol. ii. I have not met with it. Krause has also described something of the same kind.

[2] See Cloquet's Anat. pl. cxx.

to the upper surface of the tongue; and, consequently, traverse the transverse lingual muscles and the superficial lingual.

4. The Lingualis is a small narrow fasciculus of fibres, which arises indistinctly about the root of the tongue, in the yellow elastic tissue there, and advances to the tip between the hyoglossus and the genio-hyoglossus.

5. The Superficial Lingual Muscle (*superficialis linguæ*) is a broad, thin layer, covering the upper surface of the tongue, below the mucous membrane; it begins behind, on a line with the greater papillæ, and advances forwards to the tip. Its more internal fibres converge and end at the middle line, but the external ones terminate above and below near the margin of the tongue. It is rather equivocally seen in the human subject; in the calf it is very distinct.

Immediately under the superficial lingual muscle there is formed occasionally, according to my personal observations, an elliptical plane of muscle about two inches long and six or eight lines wide; the ends of its fibres begin and terminate in the middle septum of the tongue. It

Fig. 150.

Horizontal Section of Tongue about two lines below its Dorsum.—1, 1. Musculus ovalis linguæ. 2, 2. Root of tongue. 3, 3. Transverse lingual muscles.

may be called the *Ovalis Linguæ*, and can be readily found by hardening the tongue and then slicing it horizontally with a thin broad knife. Its fasciculi are parted by the ascending fibres of the genio-hyoglossi.

6. The Transverse Lingual Muscles (*transversales linguæ*) consist in small scattered fasciculi, which are placed below the last, and in the thickness of the tongue, which they traverse at right angles. One end of them, on each side, ceases at the middle line of the tongue, where there is the small seam or thin septum of fibrous matter as stated, and the other end terminates in the covering membrane of the tongue, at

the lateral margin of this organ. These fibres are to be found in the whole length of the tongue, and gradually become more curved at its base.

7. The Vertical Lingual Muscles (*verticales linguæ*) extend from the upper to the under investing membrane of the tongue. They consist in small scattered fasciculi, like the preceding, and cross them at right angles in traversing the thickness of the tongue.[1] Many of these fibres appear to me to proceed from the genio-hyoglossus.

SECT. II.—MUCOUS COVERING OF THE TONGUE.

The mucous membrane of the mouth, where it forms the frænum linguæ, is over the anterior margin of genio-hyoglossi muscles, and forms according to Fleischman[2] a pouch on each side of the frænum linguæ. The same membrane, in going from the base of the tongue to the epiglottis, and forming another frænum, has, on each side of it, a depression or pouch in which articles of food sometimes lodge. Beneath the last frænum is a ligamentous tissue (*ligament. glosso-epiglot. med.*), which runs to the base of the tongue from the front of the epiglottis, and serves to keep the latter erect: some muscular fibres are occasionally seen in this tissue in the human subject; in the black bear of North America, and in some other animals, it consists in a pair of strong muscles. The pouch, on each side, is bordered, externally, by a more superficial doubling of the mucous membrane (*ligament. glosso-epiglot. later.* or *hyo-epiglot.*), which passes, from the base of the tongue to the side of the epiglottis.[3]

The mucous membrane of the mouth, as it is reflected over the tongue so as to make an investment (*involucrum linguæ*) for it, presents some striking varieties: on the under surface it is thin and delicate, but on the upper surface it has the papillary structure well developed on the body and tip. At the base, the strength of the involucrum is considerable, owing to the abundance of the yellow fibrous or elastic tissue there, which makes a complete corium adhering to the os hyoides, the epiglottis, to the muscular fibres below, and having many mucous follicles and glands set into it. This tissue is continued forward over the dorsum of the tongue, not so thick as behind, but more condensed in its structure, so as to have a firm fibrous feel: its upper surface is studded with the papillary structure, and its lower surface receives the insertion of muscular fibres everywhere with the utmost closeness like a bone, so that there is no sliding in it. This upper portion of the involucrum may be considered as inflected downwards in the middle of the tongue so as to make the septum linguæ. The dorsal involucrum is in some cases of dyspepsia liable to lose its elasticity in lines, traversing it in

[1] The preceding views of the Superficial, Transverse and Vertical lingual muscles have been introduced by M. Gerdy of Paris. See J. Cloquet, Anat. de L'Homme, pl. cxix. cxx.—J. F. Meckel, loc. cit. Note des Traducteurs, vol. iii. p. 313.

[2] Huschke, Traité de Splanch. p. 540.

[3] This doubling also exhibits, occasionally, a small muscle inserted into its base, and arising from the upper constrictor of the pharynx, and which has the effect of widening the pouch.

different directions and extending to the base of the papillæ. This constitutes what is called the chapped tongue, difficult to cure, but improvable by lunar caustic applied along the lines.

The mucous membrane, on the dorsum of the tongue, is remarkable for the size and development of its papillæ, and for having its epidermis (*periglottis*) easily detached.

The anterior two-thirds of the upper surface of the tongue are entirely covered by these papillæ. They are so thickly set as to touch one another: and, as they present some peculiarities of form, they are divided into Papillæ Maximæ or Capitatæ, Mediæ, Villosæ, and Filiformes.

The Papillæ Maximæ constitute the posterior border of the papillary surface of the tongue, and are about nine in number, though they are frequently fewer, and sometimes more. They are much larger than the others, measuring a line or more at their base, are disposed in two oblique rows, which, by converging backwards, meet and generally form something like the letter V; the fifth papilla being the angle of the figure. Each of these bodies resembles a cone standing upon its summit, and is surrounded by a circular fossa which permits it to project but inconsiderably above the general level of the tongue. Sometimes two or more are in the same fossa.

Most commonly the central papilla maxima has the largest fossa of any of that class, and which is frequently designated by the term foramen cæcum. But the regular Foramen Cæcum, frequently deficient, is a little behind this foramen, and is not furnished with a papilla; into it some mucous follicles discharge their contents. From time to time it has been fallaciously considered as receiving the excretory duct of the thyroid, or of some of the salivary glands.

The Papillæ Mediæ, or Fungiformes, are more numerous than the last, and next to them in size; they are enlarged at their loose end into a sort of rounded head like a mushroom, whence their name; they are irregularly scattered over the tongue. Those which are next in size and still more abundant are the Papillæ Villosæ, and are of a more cylindrical shape. The Papillæ Filiformes being of a thread-like shape, fill up the intervals of the others; are the smallest, and are found principally near the middle of the tongue and at its front extremity.

The papillæ of the tongue, though they vary in their shape and size, have very much the same structure in regard to the abundance of blood-vessels and nerves which enter into their composition. When uninjected and viewed with the naked eye, their surface appears smooth, but when made turgid by injection, they are covered with little asperities or filaments, which seem to be formed principally of blood-vessels, having a very tortuous and superficial course; forming loops or doublings, in projecting on the surface of the papilla, and anastomosing freely with each other.[1] Besides vessels, there is a soft whitish substance, supposed to be nervous, entering into the composition of each filament. The larger papillæ on the back part of the tongue are supplied by the glosso-pharyngeal nerve, and the papillæ on its front part by the trigeminus or fifth pair.

[1] Sœmmering, Anat. J. Cloquet, pl. cxix.

Messrs. Todd and Bowman[1] have presented some good additional observations on the structure of the papillæ linguales. They have remarked fine hairs growing from some of them; owing to their epithelial structure or covering, becoming extremely dense. They have also, with Huschke, pointed out the existence of secondary papillæ exceedingly fine, upon the periphery of the others. We may remark that in this respect, there is a strong resemblance with the villi of the intestines of the Rhinoceros, which are very large and beset in the same way, with fine filaments projecting from them; and also with the papillæ tactus of the human skin, which from that cause have a tufted appearance under the microscope.

The surface of the tongue between the papillæ maximæ and the os hyoides is destitute of such papillæ, and is covered only by the common mucous membrane of the mouth, which is very thin there, compared to that in advance of the papillæ maximæ; and has beneath it many muciparous glands, which in different individuals produce prominences more or less elevated, and are of a lenticular shape with a diameter of a line or two. Their orifices are very visible, and easily receive a large bristle, or a probe of common size. Follicles of a small size, and comparable to those of the intestines, exist also over the whole surface of the tongue; it would seem, however, an essential mistake, to consider the papillæ maximæ as composed of them, as asserted by some.

The intervals of these gustatory papillæ, and the back of the tongue, like other parts of the lining membrane of the mouth, exhibit the ordinary papillæ tactus.

Fig. 151.

Capillary Net-work of a fungiform papilla of the tongue, injected minutely.

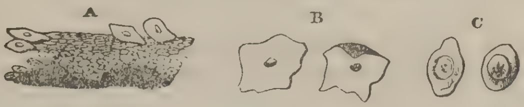
The Epidermis, which is found upon all other parts of the lining membrane of the mouth, is also continued over the whole upper surface of the tongue, and consequently invests each papilla; it is called there Peri-glottis. It is soft and humid, may be detached by maceration, and is frequently detached in fevers. On its upper surface, it, when detached, will have many elevations; while on the lower there will be corresponding excavations, which to superficial observation with transmitted light give it the appearance of being cribriform.

The tongue is supplied with arteries, principally from the lingual branch of the carotid: and with nerves from the hypoglossal, the fifth

[1] Physiol. Anat. pt. ii. p. 435.

pair, and the glosso-pharyngeal. The former nerve is considered to be exclusively appropriated to its muscular movements, and the two latter to its sensations. Its faculty of taste seems to be most active at the tip; on the sides, and near the middle behind, it is inconsiderable. The soft palate seems also to participate in the function of taste.

Fig. 152.



Comparative view of the Scales of the Epithelium. A. Section of the epithelium of the conjunctiva, some scales loosened:—B. Scales taken from the inner surface of the cheek; the margin of one is folded, a frequent appearance of these scales, showing their thinness and flexibility. C. The more deeply-seated or recently formed scales or cellules from the human conjunctiva.[1]

CHAPTER IV.

OF THE PALATE.

THE Palate (*palatum*) is composed at its anterior part of the palatine processes of the superior maxillary and palate bones, covered above by the pituitary membrane, and below by the lining membrane of the mouth. This portion of it is the hard palate, and separates the mouth from the nose. Behind it is a portion exclusively membranous, and called the soft palate, which separates partially the mouth from the upper part of the pharynx.

That part of the lining membrane of the mouth which covers the hard palate (*membrana palatina*) has a firm, fibrous feel, is not so vascular or sensible as other parts, and is made of a mixture of white and yellow fibrous tissue, which is strongly fastened to the bone. It has a ridge in its centre just beneath the middle palate suture, and from each side of it there are transverse ridges extending to the alveolar processes. This arrangement is more evident at its anterior part, and in middle-aged persons; in the old it is faint, and frequently does not exist when the alveoli are gone. Beneath this membrane, particularly at its posterior part, the muciparous glands are very abundant and closely set against each other, so as to form a perfect layer, extending itself upon the front of the soft palate, and making one-half of its thickness.

The Soft Palate (*velum pendulum palati*) has an oblong shape, and being continued from the posterior margin of the hard palate, it is stretched across the back of the mouth from one side to the other, and lies obliquely downwards and backwards. Its inferior margin,

[1] The last two figures are copied from Dr. Henle's paper, Symbolæ ad Anat. villor. intestin., imprimis eorum epithelii et vasorum lacteorum.

which is free, offers in its centre a projection of half an inch or three-quarters in length, which is the Uvula. From each side of the latter there proceed two crescentic doublings of the lining membrane of the mouth, called the lateral half arches of the palate.

The Anterior Half Arch is more distinct than the other, and arising at the side of the uvula by one end, terminates by the other in the side of the base of the tongue, on a line with the papillæ maximæ.

The Posterior Half Arch arises from the side of the uvula near the last, and diverging from it backwards and outwards, has the other end lost gradually in the lining membrane of the pharynx near its middle.

In the depression between these duplications, on either side, is the Tonsil Gland. The space bounded in front and behind by these lateral half arches is the Fauces, and the anterior opening into it is the Isthmus of the Fauces.

When the mucous membrane of the soft palate is removed, its muscles are exposed, and are as follows:—

1. The Constrictor Isthmi Faucium is a small fasciculus of fibres, on each side, within the duplicature of the anterior lateral half arch. It arises from the middle of the soft palate near the base of the uvula, and is inserted into the side of the tongue near its root in a line with the papillæ maximæ.

It tends to close the opening between the mouth and the pharynx.

2. The Palato-Pharyngeus is also a small fasciculus, within the duplicature forming the posterior lateral half arch. It arises from the middle of the soft palate near the base of the uvula, and is inserted into the pharynx at the space between the middle and the lower constrictors behind the stylo-pharyngeus, and into the posterior margin of the thyroid cartilage. It spreads itself out considerably, so as to cover, along with the stylo-pharyngeus, almost the whole posterior lateral portion of the pharynx at its lower part.

It draws the soft palate downwards, or will draw the pharynx upwards and shorten it, and it will dilate somewhat the orifice of the Eustachian tube, by means of a connection which it forms by the small fasciculus of muscular matter, called the Levator Pharyngis internus of Eustachius.[1]

3. The Circumflexus, or Tensor Palati, is behind the pterygoid process of the sphenoid bone. It arises from the spinous process of the latter along the foramen ovale, and from the contiguous part of the Eustachian tube; it then passes downwards in contact with the ptery-

[1] Custom has sanctioned the above mode of description, but the latter does not express fully the condition of this muscle, for it is a well-marked broad fasciculus below. It would be more conformable to nature to say, that it arises from almost the whole posterior margin of the thyroid cartilage, being there much spread out; that it ascends within the constrictors of the pharynx by collecting its fasciculi and having their number reduced; that it is inserted into the side of the soft palate; and that a point of it may be traced within the Levator Palati to the inferior corner of the cartilage of the Eustachian tube, into which it is inserted. This slip being the Levator Pharyngis internus of Eustachius. This muscle will be better understood with the description of the pharynx.

goideus internus muscle, and terminates in a broad tendon below, which winds around the hook of the internal pterygoid process, and is inserted into the soft palate near its middle, and into the posterior lunated edge of the palate bone.

It spreads out or extends the palate.

4. The Levator Palati is on the inner side of the last. It arises from the point of the petrous bone, and from the contiguous part of the Eustachian tube, and passes downwards to be inserted into the side of the soft palate, not far from its middle. This muscle, in the external dissection of the pharynx, may be seen between its external edge and the pterygoideus internus muscle.

It draws the soft palate upwards.

5. The Azygos Uvulæ is in the centre of the soft palate and of the uvula. It arises from the posterior pointed termination (*spina nasalis posterior*), of the middle palate suture, and goes down into the uvula. The origin of this muscle adheres also to the posterior margin of the septum narium, and its point below stops half an inch short of the inferior end of the uvula. When the mucous membrane at the tip of the latter is laid open, it will be found that the tip is formed of a loose areolar substance, with some small salivary or muciparous glands scattered through it. The morbid elongation of the uvula is confined to the tip, and seldom extends to the muscle, hence the excision of the tip answers every purpose when such an operation is demanded.

The Azygos Uvulæ is just under the posterior mucous membrane of the soft palate.

It draws the uvula upwards, and diminishes the vertical breadth of the soft palate. The precise use of the uvula is undetermined; it is supposed to regulate the pronunciation of certain letters, especially R. It appears to me to be chiefly employed in making the inferior margin of the soft palate fit well against the back and upper half of the pharynx, in vomiting and other motions, and thereby occluding the nose for the time.

The symmetrical division of it is sometimes very strongly marked by a seam, hence the muscle looks like two, closely adherent, and is by some called the Levatores Uvulæ.

Dr. Tourtual has detected a small muscle connected with the orifice of the Eustachian tube, and the line below of the posterior bony naris, and descending thence to be lost in the lateral and anterior part of the soft palate near the circumflexus palati.

When the mucous membrane is removed, the upper constrictor of the pharynx appears between the anterior and the posterior half arch.

The white median line of the soft palate, running to the incisive teeth, is considered by Dr. Pappenheim to be formed of longitudinal elastic fibres; which on the velum palati send filaments transversely towards the tonsils.

CHAPTER V.

OF THE GLANDS OF THE MOUTH.

These glands consist in such as are muciparous, and in such as are salivary.

SECT. I.—MUCIPAROUS GLANDS.

These glands (*glandulæ muciparæ*) are whitish, somewhat oval and flattened, and are from the fraction of a line to two lines in diameter: they are found in great abundance beneath the lining membrane of the mouth at several places, to wit: on the lips (*gland. labiales*); on the cheeks (*gland. buccales*); and also, as mentioned, at the posterior part of the upper surface of the tongue (*gland. mucip. linguæ*). The layer of them (*gland. palatinæ*), which is found under the lining membrane of the hard palate, is also continued over the anterior and the posterior surface of the soft palate, especially the anterior surface.

A great many small pores are observed on the internal surface of the mouth, which are the orifices of the ducts of these glands.

Notwithstanding the marked difference in the common mucous glands from the labial and buccal, and the close approximation in appearance of the latter two with the lobules of the salivary glands, yet the labial and buccal have almost universally been put into the category of the mucous. More correct views have, however, been lately advanced through the aid of the microscope by Henle, who now says, definitely, that the labial and buccal glands are of the same structure with the salivary. Their substance consists of a mass of round, or oval, completely closed cells of different sizes, some containing a granular matter and others perfectly formed mucous globules. A number of these cells united by cellular tissue, and, perhaps, also by a structureless membrane, form an acinus, and as such, are seated upon a branch of the excretory duct. Into this duct, mucous globules and other matter contained in the cells, are at times poured from the dehiscence of the membrane of the cells, or from its dissolving at the place of junction with the duct.

According to Henle, there are also other organs in every mucous membrane without exception; they are round or oval closed cells, visible even to the unassisted eye, being sometimes quite transparent, but at other times filled with mucous globules.[1]

The glands upon the hard and soft palate, according to the above, may also be considered as belonging to the system of salivary glands.

The Tonsils (*tonsillæ*, *amygdalæ*), situated as observed, one on

[1] Müller's Physiol. p. 479.

each side, between the half arches of the palate, are six or eight lines long, four or five wide, and about three thick. They are rather a collection of large mucous follicles, than a congeries of glandular bodies, in consequence of which their surface is very much reticulated. Owing to their being placed upon the upper constrictor of the pharynx, their mobility is very striking and considerable.

There is a very sensible difference between the Glandulæ Muciparæ Linguæ, and the Glandulæ Labiales, and Buccales. In the case of the two latter each gland has a number of microscopic orifices, perhaps one for each granule or acinus of the gland, opening in the interior of the mouth. These orifices are too small to be seen with the naked eye, and we, therefore, resort to the microscope. Such glands are also generally spheroidal. But in the case of the glandulæ linguæ, they are of a flattened lenticular shape, and each gland has a solitary large orifice proceeding from its centre to the surface of the tongue, and into which a pointed probe may be easily introduced. The tonsils are, in fact, a clustered exhibition of this arrangement, the orifices of the glands crossing each other so as to give a reticulated condition. A structure the same as that of the glandulæ linguæ is continued from them, all the way to the tonsils, over the lower part of the fauces.

It appears then that the glandulæ buccales, labiales, and palatinæ ought to be viewed as salivary glands; while the tonsils, the glandulæ muc. linguæ, and the similar continuous range to the tonsils over the bottom of the fauces, are really mucous glands.

The preceding points of structure are made more manifest by steeping the parts in spirits of wine, after macerating them for a few days in water.

I have in some cases seen the glandulæ linguæ clustered, and forming two broad elevated collections on each side of the tongue, somewhat like the tonsil gland, instead of making a uniform layer as in common.

SECT. II.—SALIVARY GLANDS.

On either side of the neck, bordering upon the mouth, there are three glandular bodies for the secretion of saliva; they are the Parotid, the Submaxillary, and the Sublingual. The fluid secreted from them is of great service in digestion, and is blended with the food in mastication, and in swallowing. According to Berzelius, it has a considerable affinity for oxygen, and consists in a white mucous substance, holding, in a state of solution, the saline articles usually found in the serum of the blood.

The Parotid Gland (*glandula parotis*) is the largest of the three, and, like the others, is of a light pink color. Owing to the space into which it is crowded, it is of a very irregular figure. It fills up the cavity on the side of the head between the mastoid process and the ramus of the lower jaw, extending beyond the edge of the latter so as to cover the posterior margin of the masseter muscle. It is somewhat pointed at its fore part. Its vertical length reaches from the zygoma above, to the angle of the jaw below; sometimes, indeed, a little lower down.

In thickness it extends from the integuments externally, to the styloid process, the styloid muscles, and the tendon of the digastricus, internally; being there only separated from the internal carotid artery by these parts. It is traversed from behind forwards by the portio-dura nerve, and from below upwards along its internal margin by the external carotid artery and the temporal vein.

This gland has no appropriate capsule, but being covered, on its external face, by the continuation of the fascia superficialis of the neck, prolongations are sent from the fascia which penetrate it in every direction, and keep its lobules together.

Its duct (*ductus stenonianus*), formed by a coalition of branches, departs from its anterior edge a few lines below the zygoma, and traverses the outer face of the masseter muscle, in a line, according to the observations of Dr. Physick, drawn from the lobe of the ear to the end of the nose. It is about the size of a crow-quill, is hard and tendinous, with thick parietes. It lies close to the masseter muscle, and at the anterior edge of the latter penetrates a pad of fat commonly found there on the side of the cheek; it then perforates the posterior end of the buccinator, so as to have its oral orifice opposite the second large molar tooth of the upper jaw. On opening the mouth wide during a state of fasting, a jet of saliva will sometimes indicate the position of this orifice.

A small gland (*gland. accessoria parotidis*) is sometimes found between this duct and the zygoma; it varies in form and size, and has a distinct excretory canal discharging itself into the parotid duct.

In attendance upon the parotid duct there are some small glands, called Molar, about the size of common shot, and looking like lobules of the parotid; they are found near its entrance into the buccinator, being much concealed between the buccinator and the masseter. There is some difficulty in tracing their ducts, but they probably discharge into the duct of the parotid.

The Submaxillary gland (*glandula submaxillaris*) is not more than a third or so the size of the parotid, and has a more regular form in being somewhat ovoidal. It is accommodated in the depression on the side of the neck formed by the body of the lower jaw externally, by the mylo-hyoid muscle above, and by the tendon of the digastric below. The platysma myoides intervenes between it and the skin. It almost touches the parotid gland behind, being separated from it only by the process sent in from the fascia superficialis, and continuous with the ligament, which goes from the styloid process to the ramus of the lower jaw. As it extends to the posterior margin of the mylo-hyoid muscle, it there touches the sublingual gland. The facial artery either passes through it or is very much connected with it.

Its color and appearance are the same with the parotid; but its lobules are more easily separated, as they are held together only by weak cellular substance, which forms a sort of capsule to them. Its duct (*ductus Whartonianus*), which is single, comes from the assembling and junction of branches from the several lobes. It is much

thinner, more extensible and larger in proportion than the parotid duct; and being directed backwards, winds over the posterior edge of the mylo-hyoid muscle in order to get to the cavity of the mouth. It then passes along the internal face of the sublingual gland, below the tongue, and terminates by a small projecting orifice on the anterior margin of the frænum linguæ.

A continuation of the substance of this gland (*gland. Bartholiniana*), of a few lines in thickness, described by Bartholin, is found at the posterior end of the sublingual gland, and has its excretory duct sometimes opening into the side of the duct of Wharton, and, on other occasions, into one of the ducts which issue from the sublingual gland. When this common duct exists, it is called the canal of Bartholin (*ductus Barthol.*), who first discovered it in the lion, in 1684.

The Sublingual Gland (*glandula sublingualis*) is an oblong body covered by the lining membrane of the mouth, but visible when the tongue is turned up. It is placed above the mylo-hyoid muscle, along the under surface of the tongue, and is readily distinguished by its ridged unequal surface, projecting into the mouth. It is not so large as the submaxillary gland.

Its lobules are smaller than those of the preceding gland, and are also whiter and harder. Instead of having but one excretory duct, it has several; sometimes fifteen or twenty of them are discernible: on other occasions, several of them are collected into one or two principal trunks (*ductus Riviniani*), and open either directly into the mouth, or into the duct of Wharton. These several openings are found along the bottom of the mouth, on either side below the tongue.

Several small salivary granulations or glands border on the sublingual. Among them Dr. Nuhn has designated one on each side of the tongue, at its tip, near the median line, just below the ranine artery, with about five ducts; its length is near ten lines, and its breadth about five, sometimes less.[1]

The position of the salivary glands is such, that they are much moved and pressed upon by the neighboring parts in mastication, independently of the emission of their fluid being provoked by hunger. Owing to the similitude of their structure, and to their not being supplied like other glands with regular capsules, their limits are occasionally so inexact that they continue into each other by adjacent points, and form thus an uninterrupted chain.[2]

They are all of the conglomerate kind, or consist in a congeries of smaller glands or lobes and lobules. When the duct of the parotid is injected with quicksilver, the latter readily finds its way to every part of the gland, and the ultimate lobules are exhibited as small spheriform enlargements, or cysts (*acini*). The substance of these acini is composed of small closed vesicles made of structureless membrane, and which by dehiscence or laceration discharge into the adjoining duct,

[1] Müller's Archives, 1845.
[2] Bichat, Anat. Descrip. vol. v. p. 24.

each containing its globule of mercury. Each having its little duct, some of the ducts join into larger branches, the successive coalition of which, finally, forms the principal duct; others of them are so closely upon the limits of the latter, that they discharge directly into it. In a natural state these cysts are compressed, more or less, by one another, but the tendency of the mercury, as in the case of the cells of the lungs, is to dilate them into the spheroidal shape. The same observations are applicable to all the salivary glands. These glands are well furnished with arteries, which are branches, from the external carotid, and go in several trunks instead of in a leading one. The parotid is commonly supplied by trunks coming directly from the external carotid; the submaxillary is supplied from the facial artery, and the sublingual gland from the lingual artery. Their nerves come from the fifth pair, and from the portio dura.

The retrograde injection of their excretory ducts shows how the ducts are formed by the assembling of branches from the different lobules. These ducts consist of two coats, a fibrous one externally, and a mucous one internally.

The form in which a salivary gland first appears, according to Müller and Weber, is that of a simple canal with bud-like processes; it communicates with the cavity of the mouth, and reposes in a gelatinous nidus or blastema. As the evolution goes on, the canal is more and more ramified, while the quantity of the germinal mass or blastema is diminished. The blastema afterwards assumes the lobulated form of the gland, and then disappears wholly. Thus in their earlier state, the salivary ducts can be seen to exist as a closed system of ramified tubes, but, finally, in the perfect state, their cœcal or peripheral extremities being highly attenuated, end in vesicles which cluster together like bunches of grapes. This arrangement can be well seen on filling the parotid gland with mercury from its excretory duct. The most minute pulmonary air-cells are from five to sixteen times larger than the cells of the parotid gland, and the latter have a diameter about three times larger than the capillaries which ramify upon them.[1]

CHAPTER VI.

OF THE PHARYNX AND ŒSOPHAGUS.

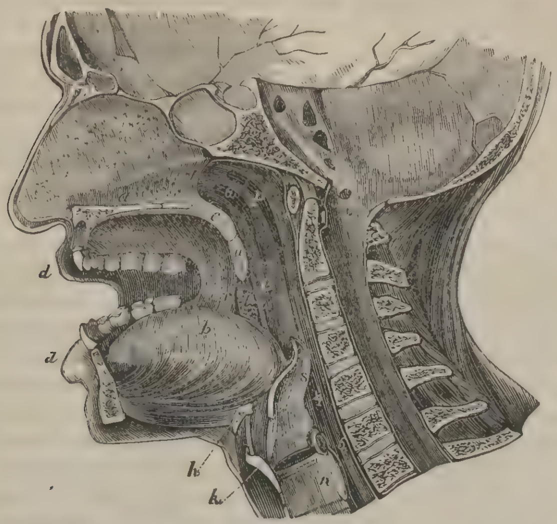
SECT. I.—OF THE PHARYNX.

The Pharynx (*pharynx*) is a large membranous cavity like a displacement funnel, placed between the cervical vertebræ and the posterior part of the nose and mouth. It extends from the base of the cranium to the lower part of the cricoid cartilage, or to the lower part

[1] Müller, vol i. 448.

of the fifth cervical vertebra. It is in contact, behind, with the vertebræ and the muscles lying upon them, being simply attached there by

Fig. 153.



Median section of the Nose, Mouth, Pharynx, and Larynx. *a*. Septum of the nose; below it, is the section of the hard palate. *b*. The tongue. *c*. Section of velum pendulum palati. *d*, *d*. Lips. *u*. Uvula. *r*. Anterior half arch or pillar of fauces. *i*. Posterior half arch. *t*. Tonsil. *p*. Pharynx. *h*. Hyoid bone. *k*. Thyroid cartilage. *n*. Cricoid cartilage *s*. Epiglottis. *v*. Glottis. 1. Posterior opening of nares. 3. Isthmus of the fauces. 4. Superior opening of larynx. 5. Passage into œsophagus. 6. Mouth of right Eustachian tube.

loose cellular substance; above, it adheres to the cuneiform process of the os occipitis and to the point of the petrous portion of the temporal bones; in front, to the lower part of the internal pterygoid processes of the sphenoid bone, to the posterior part of the upper and of the lower maxilla near the termination of their alveolar processes, to the cornua of the os hyoides, the side of the thyroid and of the cricoid cartilage; and below it is continued into the œsophagus. In consequence of these several attachments the pharynx is kept open, or its sides are prevented from collapsing, and it is drawn up and down in the motions of the tongue and of the larynx.

The Pharynx consists in three coats: an external one, formed by three muscles, on each side, one above the other, and called constrictors; an intermediate cellular coat; and an internal mucous one.

1. The Musculus Constrictor Pharyngis Inferior arises from the side of the cricoid, and from the whole length of the side of the thyroid cartilage. From these points its fibres diverge to the middle vertical line on the back of the pharynx, where they join with their congeners of the opposite side. The lower fibres are nearly if not completely horizontal, and those above increase successively in their tendency upwards, so that the upper ones approach more and more a

vertical direction, and finally reach, at their termination, to within twelve or fourteen lines of the upper part of the pharynx.

2. The Constrictor Pharyngis Medius arises from the cornu and appendix of the os hyoides, and from the ligament connecting the posterior end of the latter with the upper cornu of the thyroid cartilage. Its inferior margin is overlapped by the superior margin of the last; its fibres there are also horizontal, and, indeed, somewhat convex downwards; while the superior fibres become successively more oblique in ascending. It is inserted by the middle line behind, into its fellow of the opposite side; and by its point above into the cuneiform process of the os occipitis, just in advance of the recti majores muscles.

3. The Constrictor Pharyngis Superior arises from the lower part of the internal pterygoid process of the sphenoid bone, and below that from the back part of the upper and of the under jaw behind the last molar tooth; it is also connected at its anterior margin with the buccinator muscle, and with the root of the tongue between the anterior and the posterior half arches of the palate, being blended there with the transverse fasciculus of the stylo-glossus muscle. It has its lower edge overlapped by the constrictor medius; and its fibres are more horizontal, generally, than those of the preceding muscles. It is inserted into its fellow by a middle line, the upper end of which adheres to the cuneiform process of the os occipitis. The superior margin of this muscle between the pterygoid process of the sphenoid and the cuneiform process of the occipital makes a crescentic line, the concavity of which is upwards.

The constrictor muscles of the pharynx, by their successive contraction, convey the food from the mouth into the œsophagus.

4. The Stylo-Pharyngeus, which is mentioned among the muscles of the neck, forms an interesting portion of the structure of the pharynx, and may be considered on a footing with the longitudinal fibres of the œsophagus and of the intestines. It is intended to shorten the pharynx by arising from, or having a fixed point at the styloid process above, and by being joined into the pharynx below. Its fibres being first of all on the outside of the upper constrictor, are readily traced between the lining membrane and the two lower constrictors to the posterior margin of the thyroid cartilage; into which margin, after spreading out, they are finally inserted, more particularly into the cornu major.

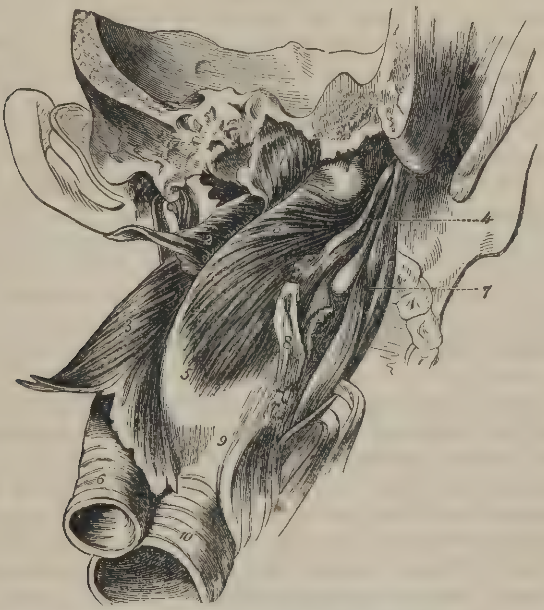
5. The Palato-pharyngeus is also an important muscle of the pharynx, and can not be well understood, except by raising from its posterior face all the constrictor muscles of the pharynx. It will then be seen that it spreads out very much like the wing of a butterfly, the shorter part being up, and there running almost horizontally within the upper constrictor. The fibres generally radiate from the soft palate, so as to make an internal muscular coat for almost the entire of the corresponding half of the pharynx, and in that way reach the middle line of the latter. The anterior margin is attached to the posterior margin of the

thyroid cartilage; and the muscle ends below on a level with the cricoid cartilage by insertion into the tunica propria of the pharynx. The stylo-pharyngeus is by no means so extensive, and its principal termination is in the posterior part of the thyro-hyoid membrane, and in the thyroid cartilage at or near the cornu major. It is placed in front of the palato-pharyngeus, but the edges of the two blend together, so that the distinction is very much lost.

The Intermediate membrane (*tunica propria*) of the pharynx is merely a thin layer of filamentous cellular tissue, destitute of fat, as in the hollow viscera elsewhere; and which joins the muscular to the mucous coat.

The Internal or Mucous Membrane of the pharynx, which lines the last, is spread uniformly over it; the only irregularity of its surface being made by the presence of mucous follicles and glands, which are more abundant above between the posterior margins of the two stylo-

Fig. 154.



View of the Muscular Structure of the Pharynx from behind. The three constrictors are raised up from their origin and turned over to the left.—1. Constrictor superior. 2 Constrictor medius. 3. Constrictor inferior. 4. Stylo-pharyngeus. 5, 5. Palato-pharyngeus. 6. Œsophagus. 7. Stylo-hyoideus and digastricus. 8. Os hyoides. 9. Posterior margin of the thyroid cartilage. 10. Trachea.

pharyngei than below. It is covered by a very delicate epidermis, and is supplied with two arteries on each side, the superior and inferior pharyngeal; the first of which comes from the internal maxillary, and the second from the external carotid. It exhibits a number of small veins, which run into the internal jugular or some of its branches.

The shape of the cavity of the pharynx is oblong and cylindrical,

being somewhat larger at its superior end. At the latter place, where it is attached to the petrous bone, it presents a deep corner, which gives it a square appearance there, and has a collection of muciparous follicles somewhat like the tonsil gland. Anteriorly, and above, it is continuous with the Eustachian tubes, and with the posterior nares; just below this, with the fauces and mouth; and below the root of the tongue with the cavity of the glottis or larynx. At its lower extremity, where it terminates in the œsophagus, it is so contracted as to suit the size of the latter cavity.

SECT. II.—OF THE ŒSOPHAGUS.

The œsophagus is the tube just in front of the spine and behind the trachea, which conducts food from the pharynx into the stomach. When inflated it is of a cylindroid shape, about ten or twelve lines in diameter; it is nine or ten inches long and gradually increases in its size from above downwards; in its state of repose it is flattened from before backwards. Its descent is not entirely vertical, but at the lower part of the neck it inclines somewhat to the left of the middle line, and is, therefore, rather to the left side of the trachea than behind it. It passes down the thorax in the posterior mediastinum, being bounded on its left side by the aorta, and on the right by the vena azygos. It keeps, during the early part of its course in this cavity, in front of the middle line of the spine; but lower down it inclines again slightly to the left side, in front of the aorta, in order to reach the œsophageal orifice of the diaphragm, through which it penetrates into the abdomen. In all this passage the œsophagus is united to adjacent parts by a loose cellular tissue.

The œsophagus is composed of three coats: the muscular; the cellular or nervous; and the mucous.

The Muscular Coat is the external, and very strong. It consists in two well marked laminæ of muscular fibres. The most exterior is the thickest, and goes, longitudinally from one end to the other of the tube; commencing according to J. F. Meckel, by three fasciculi above; one of which arises, tendinously, from the posterior face of the cricoid cartilage, and the other two, one on each side, from the inferior constrictor of the pharynx. These fasciculi descend for an inch or two, before they spread out into a uniform membrane. The internal muscular lamina consists in circular fibres, which may be considered as a continuation of the lower margin of the inferior constrictor of the pharynx, and are either horizontal or slightly spiral; they are rather deficient on the fore part of the œsophagus for an inch at its superior extremity. Individually, their length is short of the circumference of the œsophagus.

The Cellular Coat (*tunica propria*) is next in order. It is much thicker and stronger than that of the pharynx, making a layer which is very easily raised as a distinct coat, and is filamentous. It serves to

unite the muscular and the mucous together. It adheres much more closely to the latter than it does to the former, has no adipose matter in it, but is found to be abundantly furnished, more particularly towards its upper end, with small muciparous glands; it also serves to transmit the blood-vessels through the structure of the œsophagus.

The Mucous Coat of the œsophagus is the most internal; in the undistended state it always presents many longitudinal folds, going from one end to the other, but sometimes blending with each other, owing to the contraction of the circular muscular fibres. When suspended in water, its fine villous appearance is very perceptible, as well as the mucous lacunæ or glands which open upon its internal surface. As it is a continuation of the mucous membrane of the pharynx, it has the same general appearance, but is rather whiter. Its internal surface is also covered by a delicate epidermis, which ceases at the cardiac orifice of the stomach, and may be raised in shreds by maceration and by boiling. In some pathological conditions this epidermis becomes very distinct by acquiring more thickness and solidity than what belongs to its healthy state.

The arteries of the œsophagus are derived from the inferior thyroidal, from the thoracic aorta, and from the gastric. Its nerves come principally from the pneumogastric.

Prof. Hyrtl, of Vienna, has described two muscles in connection with the œsophagus, which he calls broncho-œsophageal, and pleuro-œsophageal. The first is higher, arises by a broad base from the posterior face of the left bronchus, and is inserted into the left side of the œsophagus, by mingling with its longitudinal fibres for two or three inches. The other arises on the left side from the posterior mediastinum, behind the aorta, and turns around the latter to reach the œsophagus. The first is supposed to give more fixedness to the left bronchus, and the other to do the same for the œsophagus.[1] These muscles are rather rare; in a recent dissection, however, at the University,[2] I met with a specimen of them very much as described.

[1] Br. and For. Med. Rev. p. 269. Jan. 1845.
[2] Feb. 11, 1851.

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